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REVIEW OF THE MONTH

Motorola Razr 60 Ultra

The problem with most flip phones is the need for compromise. Disappointing cameras. Terrible battery life. Lacklustre speed. And with early phones in particular it was hard not to be distracted by the thin line in the middle of the screen. But of course you know why we've said all this, don't you? Yep: the Razr 60 Ultra is a flip phone that doesn't compromise. Somehow, it packs a 4,700mAh battery, not far off the biggest you'll find in normal phones. It also features a strong set of cameras and the fastest CPU currently available for Android phones. Enough to make you flip? Find out on p46.

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Susan Postlethwaite

To you, robotics and fashion may appear to clash. To Susan Postlethwaite of Manchester Metropolitan University's Fashion Institute, they go together like blazers and jeans (best not to come to us for fashion advice). See why on p126.

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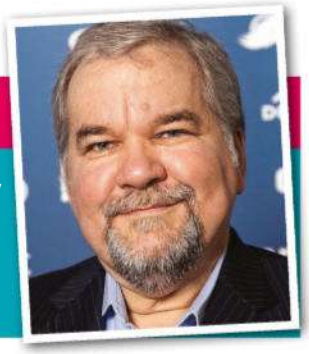

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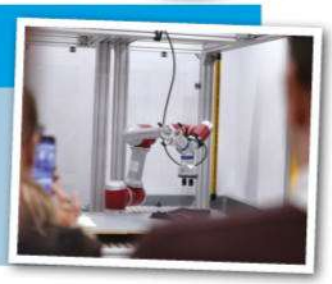

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Don't believe in AI? You need to get with the program

There's something about technology that makes people angry. I've just heard Elton John declare that he feels "incredibly betrayed" over the government's copyright-liberal stance on AI, and I can see why. I suspect many of the thousands of people who have lost their jobs due to AI's impact feel a similar way.

So, how do I feel about *PC Pro* publishing a feature all about coding with AI? Turn to our poll on p25, a page before that feature starts, and you'll see that many of our readers identify themselves as professional coders. Are we not deprecating their skills by publishing advice on how to hack something together with AI?

No. I can't bring myself to feel guilty. Perhaps I will in a decade's time, when the impact of this kind of article and the belief system it implies – "AI can make us better so let's jump aboard" – becomes clearer. Right now, I take the view that ignoring AI, or building up defences against it, is an error. One founded on a misunderstanding about what AI is.

My first witness for the defence is a Mr Reginald Dwight from Pinner. In his criticism of the technology, he has expressed the belief that a computer is "incapable of writing anything with any soul in it". Yes, absolutely. And I don't think it ever will.

That's because computers – and this can be hard to accept when they act so frequently against our wishes – don't have souls. They have zeros and ones, transistors and capacitors, but those can never make them equals to the flawed, organic, wonderful creatures that we call humans.

Appearances can be deceptive. Back in 1949, Alan Turing told a reporter: "In time, which may be years, of course, it should be possible to perfect and adapt the [electronic] brain so that it is capable of acting without human instructions, even of making decisions itself. I don't even draw the line about it writing a sonnet on a sunset."

And that prediction soon came true, in a sense. Within five years, one of Turing's friends, an early computer scientist called Christopher Strachey, had written a program to generate love poems. In places its output sounds genuinely soulful: "You are my wistful sympathy; my tender liking." But it's an illusion: the humanity was not in the machine, but in the programming, as Strachey explained in an article called "The 'Thinking' Machine" that you can Google – sorry, I mean, you can find if you head to your local library and manually search through all the British scientific journals published in 1954.

As Strachey brilliantly wrote: "It is impossible to over-emphasise the importance of the program; without it a computer is like a typewriter without a typist or a piano without a pianist."

It's true. You can now spend hours watching robots on YouTube play pianos with extreme technical virtuosity. But only a human can sit at a piano and pour their hearts into a performance that will catch your soul – Elton performing his tribute to the Princess of Wales springs to mind – because that is the wonder of being human. We connect with other people on a deep, fundamental level that no computer will ever understand. It's what makes us human – and it's what allows us to get angry.

Tim Danton
Editor-in-chief

PC Pro needs your help!

Who will win this year's *PC Pro* Excellence Awards? Only you can tell us, so please complete our survey so we can find out!

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In this month's PC Probe (*see p12*), we investigate the Apple tax: the 27% to 30% levy on app developers for payments. Do you think Apple (or other app store owners) should take a cut of sales made off-platform?

"We need a balance, and until this court action the pendulum had swung too far the way of Apple and Google. If companies react to these 'taxes' by removing the ability to purchase direct from an app, who's really benefitting? Apple and Google alike need to realise their first priority is customers, not shareholders, or they will lose out in the long-term and that helps neither."

"Don't understand the question – what is this Apple of which you speak?"

"Absolutely not. Frankly I don't think Apple should be getting a cut of sales made on-platform, beyond a nominal processing fee."

"No, it's absolutely outrageous that this was ever a thing in the first place, and indicative of the power the app store owners hold over developers."

"For free apps, yes. For paid apps, no. If people are giving away the product for free but charging for content as a way of getting around any kind of revenue going to Apple, it doesn't seem fair that Apple has to approve, host and manage the app for free when all of the revenue is going to the developer. But Apple shouldn't get 27% from off-platform sales if it's already taken a cut."

"If you look at it as a rate of interest, not a tax, then it's positively generous in the era of the 75% credit card interest, 48% overdraft and so on."

"Yes. The App Store is a powerful shop window which hosts, reviews and makes installs easy. That shouldn't come without cost but a 27% to 30% slice seems high. Coincidentally it's exactly 27% to 30% more than Microsoft pays me for 365 renewals on PCs I sell to customers."

"Find me another large retail platform that doesn't charge, either retail or bricks and mortar."

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Briefing

Background and analysis on all the important news stories

Retail on ransomware red alert

Surge in malware attacks on businesses leaves UK retailers reeling

Marks & Spencer's online orders have been "paused" for almost a month; Co-op has admitted the loss of customer data and other operational difficulties; even Harrods was battening down the hatches to fend off a cyberattack. It has been a fraught month for British retailers.

All three are believed to be victims of the ransomware group DragonForce, which runs its own affiliate scheme for freelance hackers in much the same way that Amazon pays commission for driving sales to its site.

It's fuelling a 22% year-on-year increase in ransomware attacks on the consumer goods and services sector, according to the security company Check Point, while the National Cyber Security Centre (NCSC) has offered stark warnings for other retailers to check their systems and be on high alert. If you're working in the IT department of a retailer this summer, be prepared to cancel all leave.

How did the hackers get so deep into the retailers' systems? It wasn't through lax gateway security so much as old-fashioned human failings. IT support desks were conned into resetting the credentials of employees, some of which appeared to have admin-level privileges on the network.

Check Point's head of public sector, Graeme Stewart, says AI has made it easier than ever to break into corporate systems. "If you take these DragonForce guys, they're now using AI large language models to develop malware and to do audio-visual impersonations and deepfakes to break in and make these calls to help desks," he said.

Once inside the network, the attackers aren't only after the rich seams of customer data but causing maximum disruption to the retailers' operations. Marks & Spencer is "having a terrible time," said Stewart, "because it's actually knocked down their logistic setup. They can't get stuff onto the shelves. The data exfiltration is, to my mind, of secondary importance."

That should be sounding alarm bells at the highest levels of government, because "retailers are effectively part of the critical national infrastructure (CNI), and if you can take services offline for CNI organisations, that has a massive impact," said Stewart. Imagine if one of the major supermarkets was unable to properly fill its shelves for a period of weeks – it would make the Covid-era shortages look like a minor blip.

> "They're now using AI large language models to develop malware and to do audio-visual impersonations and deepfakes to break in"

British retailers including Marks & Spencer and Co-op have been hard hit by AI-fuelled ransomware attacks

And make no mistake, these ransomware groups would love to take down even bigger targets than they have already. "Part of the reason they do this is there is no small amount of machismo attached to this," said Stewart. "It's kind of like graffiti and tagging.

"'Look at what I've done, look at where I've done it, look at the mess that I've caused.'"

Forgetting the fire drills

A fortnight after the attacks on Marks & Spencer and Co-op were made public, the NCSC published fresh guidance. This urged organisations to ensure two-step verification was "deployed comprehensively" across their business and to "enhance monitoring against unauthorised account misuse", among other measures. While Stewart believes that's good advice, he warns that the real problem is that companies are unable to recover quickly from an attack because they've "not practised".

"Organisations don't spend enough time doing the fire drill, and so that makes the recovery more difficult," he said. "Generally, UK industry is not as well prepared and drilled for this as it ought to be."

The other area that's neglected is outsourcing arrangements, said Stewart, especially when they're running critical infrastructure such as IT support. He said it's essential that contracts with third-party providers "reflect the gravity of a data breach".

"If it doesn't reflect the gravity of the breach, then you're not going to take it seriously enough. And if you're not contracting on that basis, that's what gives you the issue."

Not paying the ransom

The longevity of the Marks & Spencer problems suggest at least one positive: the company hasn't succumbed to paying off the attackers. "It's encouraging – in the same way that not negotiating with kidnappers is morally admirable," said Graham Cluley, the former Sophos executive and now host of the Smashing Security podcast. "Paying a ransom funds cybercriminal gangs and encourages more ransomware attacks."

However, Cluley admits that not taking the easy option can be "really painful", as Marks & Spencer is discovering. The attack has wiped more than £500 million off the company's share value at the time of writing, and ongoing losses for the suspension of its online store have been estimated at £15m per week, alongside £30m to rectify systems.

"That's not to say that I don't sympathise with those companies who decide that paying is the 'least worst' option," Cluley added. "When ransomware hits a retailer and sales grind to a halt, every minute is going to be costing money – lots of it. Cybercriminals know that there are big profits to be made if they manage to extort a retailer."

In that sense, the theft of customer data becomes an insurance policy. If the victim refuses to pay up, the hacking group might still be able to sell the customer data to other criminals, even if such data is becoming less lucrative due to the sheer volume of personal data that's now for sale on the black market.

"You could probably get most of that information from the phone book and Facebook," said Stewart of the personal data that was stolen. "Taking the services offline is the bit that gets you."

He added: "No-one cares that they've had their data pinched," recounting a story from a couple of days previously, when he'd pulled into a Marks & Spencer store attached to a petrol garage and found the shelves almost bare. "What they care about is when they pull into a garage at midnight on a Saturday night gasping for a can of Coke and a bag of crisps, there's nothing on the shelves. That's the big one."

Online Safety Act challenged by Wikipedia

Controversial legislation faces first legal challenge

The Wikimedia Foundation is challenging the lawfulness of the Online Safety Act, after Wikipedia was put at "unacceptable risk" of being subjected to the Act's toughest duties.

Although regulator Ofcom had yet to determine which category Wikipedia would be placed in at the time of writing, the Wikimedia Foundation believes it's at significant risk of being deemed a "Category 1" site, which Parliament designated for services posing the biggest risk to society.

The Foundation claims the criteria for deciding which category a site fits into are "flawed" and "have no real connection to actual safety concerns". The criteria that will determine the site's fate include the use of content recommendation systems, the ability to share content and the popularity of the platform, all of which are applicable to Wikipedia.

If Wikipedia is designated a Category 1 site, the Foundation claims that it will be forced to verify the identity of its users and moderators, who often have to deal with highly sensitive topics. This could "expose users to data breaches, stalking, vexatious lawsuits or even imprisonment by authoritarian regimes," the Wikimedia Foundation's lead counsel, Phil Bradley-Schmieg, argued in a blog post.

Bradley-Schmieg added that placing Wikipedia in the same category of risk as social-media sites was disingenuous. "Wikipedia is not like social media. [It] relies on empowered volunteer users working together to decide what appears on the website. This new duty would be exceptionally burdensome.

"Privacy is central to how we keep users safe and empowered," he added. "Designed for social media, this is just one of several Category 1 duties that could seriously harm Wikipedia."

The case is the first example of regulatory overreach that many cautioned against when the Online Safety Bill was making its way through Parliament. Alex Davies-Jones MP, now a justice minister, said in 2023 that "categorisation of services based on size rather than risk of harm will mean the bill will fail to address some of the most extreme harms on the internet.

"Smaller platforms such as 4chan and BitChute have significant numbers of users who are highly motivated to promote very dangerous content," she added. "Their aim is to promote radicalisation, and to spread hate and harm."

Ofcom declined to comment on the legal challenge.

Trouble in Store for Apple

Barry Collins investigates the problems facing Apple after its stinging court defeat to Epic Games

If you head to YouTube, you'll find a five-minute video of Steve Jobs on stage at WWDC in 1997. In it, he answers a pointed question from a snotty developer who tells Jobs it's "clear that on several accounts you've discussed, you don't know what you're talking about".

The developer is upset that Jobs has seemingly chosen Java over OpenDoc. Jobs takes a long pause, a slug of water and then justifies his decision to the developer, implying it's a fool's errand to pick a technology and then work out how to make it work for the consumer. "As we have tried to come up with a strategy and a vision for Apple, it started with what incredible benefits we can give to the customer."

Somewhere along the line, it appears Apple lost sight of that strategy. What "incredible benefits" do customers get from forcing Spotify to hide links to cheaper subscriptions in its iOS app? Or preventing Kindle app owners from buying books directly in-app? It's much easier to see the incredible benefit Apple can give to itself, as it insists on taking a cut on every purchase, whether the app developer is using Apple's payment system or not.

It's a decision that has infuriated a federal judge in California, too. "Apple's continued attempts to interfere with competition will not be tolerated," ruled district judge Yvonne Gonzalez Rogers in an excoriating judgment against the company in late April. One in which she accused the company and its officers of contempt – both civil and criminal. The judgment brought an immediate end to Apple's practice of charging a 27% commission on off-app purchases and preventing developers from linking to their own payment systems.

Apple is, of course, appealing, but for now let's examine who the big winners and losers are from the court's extraordinary judgment.

An Epic victory

The judgment against Apple is the latest salvo in the long-running case brought by Epic Games. Back in 2020, Epic Games provoked Apple into ejecting its *Fortnite* app from the App Store after inviting gamers to buy in-game credits using Epic's own payment system rather than Apple's, a contravention of the App Store rules.

> "Apple imposed a 27% commission on off-app purchases, something the court has now ruled was a 'gross miscalculation'"

Epic took Apple to court in the Northern District of California, claiming the company was a monopolist and anti-competitive. A case it largely lost. However, it did prevail on one issue: it won the right to steer consumers towards alternate payment systems outside of the app. Apple responded by imposing a 27% commission on those off-app purchases, something the court has now ruled was a "gross miscalculation" and a means to "maintain its anticompetitive revenue stream".

A rare glimpse inside Apple

The court ruling from the Northern District of California gave us a rare insight into the inner workings of the normally highly secretive Apple. In particular, it exposed divisions among the ranks of senior executives over whether or not to apply a commission on off-app purchases.

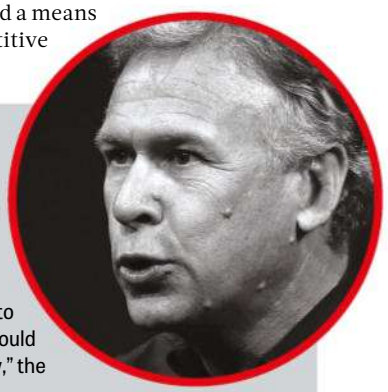
The court documents reveal how the executive committee was split in a meeting held on 20 June 2023. "Those advocating for a commission included [chief financial officer] Mr Maestri and [vice president of finance] Mr Roman," the court judgment states. "In an email, [App Store chief] Mr Schiller relayed that, with respect to the proposal for 'a 27% commission for 24 hours', 'I have already explained my many issues with the commission concept,' and that 'clearly I am not on team commission/fee'."

The court judgment also reveals that, "unlike Mr Maestri and Mr Roman, Mr Schiller sat through the entire underlying trial and actually read the entire 180-page decision. That Messrs Maestri and Roman did neither, does not shield Apple of its knowledge (actual and constructive) of the Court's findings."

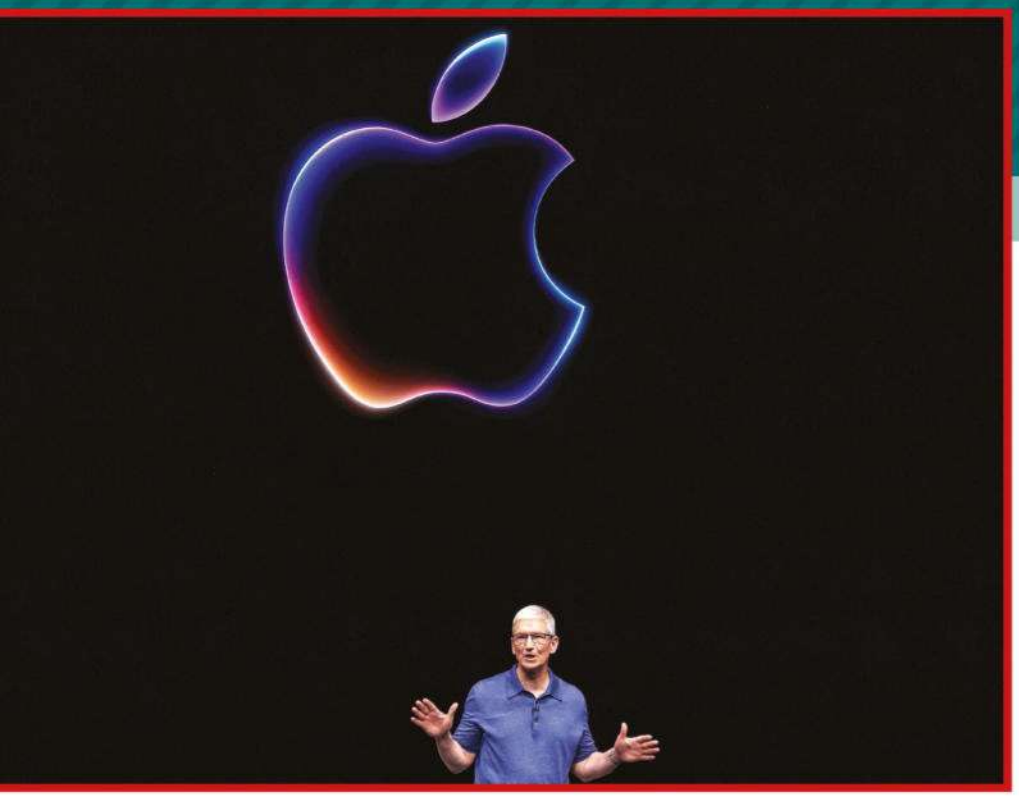
Details of a further meeting on 5 July 2023 reveal that Tim Cook had to settle the dispute. "One purpose of this meeting was to settle on the commission rate that Apple would charge and its associated tracking window," the judgment reads.

"Apple settled on a 27% commission for linked-out purchases, a decision ultimately made by Messrs Cook, Maestri, and Schiller. As Mr Schiller was not advocating for a commission, and Mr Maestri was fully advocating for the lucrative approach, Mr Cook was the tie-breaker.

"Commissions would be collected on a seven-day window, even if those subsequent purchases on a developer's website were made on a device other than the user's iPhone. Thus, in response to the injunction, Apple chose to impose a new commission representing the most anti-competitive option considered."



ABOVE Phil Schiller's advice was not taken by fellow executives



Epic took immediate delight in the ruling from the district court. "We will return *Fortnite* to the US iOS App Store next week," CEO Tim Sweeney posted on X, and a couple of days later was lauding Spotify for amending its iOS app in the US with links to purchase subscriptions directly from Spotify. "Congratulations to Spotify on being the first major iOS app to exercise its court-mandated right to do digital commerce with customers free of Apple obstruction, interference, and the Apple Tax!"

Spotify itself put out a statement, praising the court's ruling for making it "clear that Apple deliberately abused its market power to intentionally harm others and benefit only itself".

Industry analysts agree that the victors from all this are the major players such as Epic and Spotify: for the time being at least, they're free from the Apple levy. For apps where "you're paying a monthly subscription for a service like a Spotify, or you're doing something like an Amazon where you're just buying stuff that's available elsewhere, they're the big, big winners because they're high-volume players," said Ben Wood, chief analyst at CCS Insight.

Do consumers win, too? That really is a "time will tell" situation. Ultimately, consumers only win if the purchases they make are cheaper because Apple is no longer taking a commission. If the app developers just pocket what they would have paid in commission for themselves, the consumer is no better off.

In its statement, Spotify said that the ruling means consumers "can finally see how much something costs in our app, including pricing details on subscriptions and information about promotions that will save money", adding that it might also open new opportunities. "These changes should soon allow publishers to sell their audiobooks through Spotify's platform seamlessly."

We don't yet know if Epic's customers will benefit. *Fortnite* has yet to return to the App Store at the time of writing, although when the *Fortnite* app flouted the rules back in 2020, Epic made a point of offering discounts of 20% to gamers who used its own payment system.

Trouble for Apple

On the other side of the fence, Apple is facing problems on multiple fronts. First, if the ruling is upheld and Apple can no longer take a cut on off-app purchases, it's going to take a financial hit.

Apple's earnings reports aren't granular enough for us to work out precisely how much it stands to lose, but there are clues in the motion to stay that Apple lodged in early May, trying to get the judgment put on hold until a full appeal can be heard. "The district court acknowledged that compliance will cost Apple 'hundreds of millions to billions' of dollars annually, which Apple can never recoup," the company's motion stated.

Lest anyone consider launching a crowdfunder to ensure Apple survives the financial turmoil, even a low billions annual hit won't put a serious dent in the company's profits. It made almost $94 billion in net income in 2024.

If Apple does manage to overturn the court's decision, the fact that Spotify and others have rushed in to amend their apps will make it harder for Apple to turn back the clock. "The precedent has been set," said Ben Wood, referring to apps offering off-app payments, in the US at least. "Reversing it would be quite an undertaking as well, and would generate a lot of bad will."

ABOVE Apple CEO Tim Cook "chose poorly", according to the judgment

Perhaps more worrying for Apple is the threat of contempt proceedings against its senior executives. The judgment was scathing about the conduct of Tim Cook and other senior Apple executives, accusing them of deliberately trying to circumvent the court's will. "Apple sought to maintain a revenue stream worth billions in direct defiance of this court's Injunction," the verdict read.

"In stark contrast to Apple's initial in-court testimony, contemporaneous business documents (*see "A rare glimpse inside Apple", opposite*) reveal that Apple knew exactly what it was doing and at every turn chose the most anti-competitive option," it continued. "To hide the truth, vice-president of finance, Alex Roman, outright lied under oath. Internally, [App Store chief] Philip Schiller had advocated that Apple comply with the injunction, but Tim Cook ignored Schiller and instead allowed chief financial officer Luca Maestri and his finance team to convince him otherwise. Cook chose poorly."

> **"Documents reveal that Apple knew exactly what it was doing and at every turn chose the most anti-competitive option"**

Judgments don't come much more damning, or more personal, than that. The district court has referred the matter to the attorney for the Northern District of California to determine whether there's a case for criminal contempt proceedings. That could potentially lead to imprisonment for executives found guilty.

All of this hangs on the verdict not being overturned. As Ben Wood states, at least one party is keen to see an appeal fail. "You've got to admire the tenacity of Epic [Games]," he said. "They've been relentless in pursuing this, and it's meant they've got knocked out of the [App] Store, they've lost revenue, it's no doubt cost them a small fortune in legal fees, but they just have not let it go.

"From their side of things, they'll be very keen to make sure that this ruling now sticks."

The A-List

The best products on the market, as picked by our editors

PC PRO A-LIST

PREMIUM LAPTOPS

Apple MacBook Pro M4

M4 beast from £1,599

from apple.com/uk

This M4 update to the already brilliant MacBook Pro line is an easy recommendation, so the big question becomes do you choose the 14in version from £1,599 or 16in from £2,499? And then how much do you upgrade, as Apple isn't afraid of high prices. But whatever you choose should last for years, and look great while it's doing it.
REVIEW **Issue 364, p50**

Apple MacBook Air M4

If you don't need the all-out power of the Pro, this is a brilliant, cheaper alternative despite the unchanged chassis and screen. **13in from £999, 15in from £1,199 from apple.com/uk**
REVIEW **Issue 368, p54**

Asus Zenbook S 14 OLED

Asus pairs a Core Ultra 9 288V with a 72Wh battery to produce a laptop that lasts almost 20 hours on a charge. What's more, this 1.2kg machine looks (and feels) the business. **From £1,750 from scan.co.uk**
REVIEW **Issue 362, p46**

Asus ProArt PX13

With AMD's new Ryzen AI 9 HX 370 inside, this 1.4kg compact powerhouse offers incredible amounts of power. Add a fantastic OLED screen and RTX 4070 graphics and it's a winner. **From £2,000 from uk.store.asus.com**
REVIEW **Issue 361, p50**

BUSINESS LAPTOPS

Dell Pro 13 Premium

Sheer quality from £1,452 exc VAT

from dell.com

Dell's business laptop series has a new name, but its commitment to build quality and astonishing levels of configuration remain the same. Here, you benefit from a 1.1kg weight and 24-hour battery life, with Intel's 200V vPro series there for easier remote management. Just make sure you avoid the cheap screen option.
REVIEW **Issue 368, p46**

NEW ENTRY

Lenovo ThinkPad X1 Carbon Gen 13

The best executive laptop out there, with true all-day battery life even if you buy the 14in OLED version. At 1kg and with the latest components, it's worth the price. **From £1,875 exc VAT from lenovo.com**
REVIEW **Issue 370, p52**

Lenovo ThinkPad T14s Gen 6 (Snapdragon)

There's no better laptop if you want to try out Snapdragon, thanks to its combination of build quality, speed and battery life. **£1,500 exc VAT from lenovo.com**
REVIEW **Issue 360, p56**

HP OmniBook Ultra Flip

A top-quality 2-in-1 with a terrific 14in OLED panel, great build quality and superb battery life thanks to Intel's latest generation Core Ultra 7 processors. **From £1,699 from hp.com**
REVIEW **Issue 365, p46**

GAMING LAPTOPS

NEW ENTRY

Lenovo Legion Pro 7i Gen 10

RTX 50 power from £2,800

from lenovo.com

A surprisingly elegant chassis considering the power within, even if it still weighs 2.7kg. In return you get a 16in OLED panel, Intel Core Ultra 9 275HX CPU and, in our test system's case, and Nvidia RTX 5080 GPU. Lenovo simply doesn't put a foot wrong.
REVIEW **Issue 370, p75**

NEW ENTRY

Asus ROG Zephyrus G14 (2025)

AMD's Ryzen AI 9 HX 370 CPU combined superbly with the RTX 5080 GPU in this slimline chassis complete with 14in OLED panel. **RTX 5080, £3,200 from asus.com**
REVIEW **Issue 370, p72**

NEW ENTRY

Medion Erazer Beast 16 X1 Ultimate

Not the most refined 16in laptop, but with RTX 5090 graphics at RTX 5080 prices it's great value. **RTX 5090, £3,500 from scan.co.uk**
REVIEW **Issue 370, p54**

NEW ENTRY

Asus ROG Strix Scar 18 (2025)

Don't want to make any compromises? Choose this 18in monster, which weighs 3.3kg but extracts every drop from its components. **RTX 5090, £4,700 from asus.com**
REVIEW **Issue 370, p71**

EVERYDAY LAPTOPS

Acer Aspire 14 A14-51GM

Compact power for £850

from acer.com

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price.
REVIEW **Issue 359, p82**

Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099 from uk.store.asus.com**
REVIEW **Issue 359, p58**

Framework Laptop 13 (DIY Edition)

With a competitive price, modular approach and easy-to-repair ethos, you can pick and mix your perfect 13in laptop. **From £779 from frame.work**
REVIEW **Issue 360, p58**

MSI Prestige 13 AI+ Evo A2VM

Astonishingly good value whether you buy the Core 7 or Core 9 Ultra versions, this sub-1kg laptop packs a great screen, power and supreme battery life. **From £899 from currys.co.uk**
REVIEW **Issue 369, p60**

CHROMEBOOKS

Samsung Galaxy Chromebook Plus (2024)

Core 5 power for £749

from samsung.com

The first truly desirable Chromebook since the Pixelbook, this is a top-quality laptop from the all-metal chassis to the 15.6in Full HD OLED screen. And thanks to Intel's Core 5 120U processor, it's fast enough to last for years.

REVIEW Issue 364, p65

Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from currys.co.uk**

REVIEW Issue 356, p82

Acer Chromebook Spin 714

If you're looking for a convertible, this is the best choice around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this 2-in-1 for the money.**£799 from currys.co.uk**

REVIEW Issue 356, p83

MINI PCs

Apple Mac mini M4

Little monster from £599

from apple.com/uk

This is a big and timely update for the Mac mini, with a much smaller (and squarer) design that's easy to tuck behind a screen. But what lifts it above the pack is the astonishing power of the M4 and M4 Pro chips, with barely any cooling required. As ever with Apple the upgrade costs are high, but at least its starting price is reasonable.

REVIEW Issue 364, p44

Geekom A6 Mini PC

The Geekom A6 Mini PC steals the A8's place on our A List thanks to its sheer value for money. The A6 costs £220 less but doesn't compromise on quality or connectivity, and while the Ryzen 7 6800H is a step down from the Ryzen 9 8945HS in the A8, it remains a superb performer.

£499 from geekom.co.uk

REVIEW Issue 367, p56

Minisforum Venus UM790 Pro

Ignore its basic looks, for this compact system packs in a fast AMD Ryzen 9 7940HS processor, 32GB of DDR5-5600 RAM and 1TB SSD along with a generous selection of ports, including two USB-C 4 connectors. And the price is super-aggressive.

£549 from store.minisforum.uk

REVIEW Issue 363, p91

ENTHUSIAST PCs

NEW ENTRY

Scan 3XS Edge iCue

Silent but deadly fast for £2,800

from scan.co.uk

With the RTX 5080 comes a refresh of best enthusiast PCs. The Scan is a shade slower than its Ryzen 9 9800X3D rival from Wired2Fire, but even at full pelt it remains astonishingly quiet.

REVIEW Issue 367, p50

CyberPower PC Ultra 3D5090

If you're after the fastest gaming PC you can buy for £4,000, let's make things easy for you: buy this. It's packed with speedy components, from AMD's Ryzen 9 9950X3D to RTX 5090 graphics to a 2TB Gen 5 SSD.

£4,000 from tinyurl.com/370cyber

REVIEW Issue 370, p58

PCSpecialist Hydra R60S

This compact PC makes little noise but still packs a gaming and creative punch thanks to RTX 4060 graphics and AMD's older but speedy Ryzen 5 7500F. You can upgrade to an RTX 5070 when budget allows. **£999 from pcspecialist.co.uk/reviews**

REVIEW Issue 368, p60

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from hp.com

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

REVIEW Issue 335, p46

Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

From £599 from dell.co.uk

REVIEW Issue 350, p47

Apple iMac M4

Anyone hoping for a 27in iMac will be disappointed, but everyone else should be delighted by this M4-powered all-in-one with its 24in 4,480 x 2,520 IPS panel. It's fast inside and out, too, with Thunderbolt 4 and Wi-Fi 6E both part of the package. **From £1,299 from apple.com/uk**

REVIEW Issue 364, p48

CREATIVE WORKSTATIONS

Armari Magnetar M64T7-AW1650G4

Threadripping power for £8,329 exc VAT

from armari.com

AMD's Ryzen Threadripper 7980X is the star of this particular show, dominating our benchmarks with the help of 128GB of RAM, two 2TB Crucial PCI-E 5 drives in RAID0 configuration and AMD's Radeon Pro W7800 professional GPU. And it's all wrapped up in a custom Armari case with liquid cooling.

REVIEW Issue 361, p92

Scan 3XS Evolve Studio Pro

Thanks to its combination of a Ryzen 9 9950X3D and GeForce RTX 5090, this will race through games – but it's also a fantastic choice for 3D animation and modelling. With top-quality components throughout and a gorgeous case, it will perform for years. **£4,167 exc VAT from tinyurl.com/369scan**

REVIEW Issue 369, p48

Apple Mac Studio

Now updated with your choice of M3 Ultra or M4 Max chips, this is the natural choice for professionals who rely on Apple hardware (or software). As with all Apple products, prices rocket once you add memory and storage, but this is a long-term investment. **From £1,749 exc VAT from apple.com**

REVIEW Issue 369, p52

TABLETS

Apple iPad Air M3

Languid power from £599

from apple.com/uk

It's hard to be too excited by this update as it's exactly the same design but with an M3 chip inside. But when the original was so damn good, whether in 11in or 13in variants, and Apple Intelligence is thrown in, it remains the best choice for the vast majority of tablet buyers.

REVIEW **Issue 368, p56**

Apple iPad Pro M4

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from apple.com**

REVIEW **Issue 358, p48**

OnePlus Pad 2

Last year the OnePlus Pad took its place alongside Apple's iPads on the A List – and this year it's done it again, with superb battery life of over 18 hours, a gorgeous design and great power making this new version an even better proposition. All for a price that's exactly right. **£449 from oneplus.com/uk**

REVIEW **Issue 364, p86**

EVERYDAY PHONES

Google Pixel 9a

Why pay more? From £499

from store.google.com

If you can live without an optical zoom then it's hard to think of a reason to pay more for a phone. The AI features are genuinely useful, it's fast, the battery lasts forever, the camera is superb and the 6.3in OLED panel is a joy to gaze at.

REVIEW **Issue 369, p74**

Nothing Phone 3a

Looking to get the best possible phone for around £300? This is it. Quite aside from Nothing's unique design, it features a gorgeous display and high-quality cameras – including an optical zoom that few phones in this price bracket can match. **£329 from nothing.tech**

REVIEW **Issue 368, p77**

Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too. **128GB, £364 from johnlewis.com**

REVIEW **Issue 358, p77**

PREMIUM PHONES

Samsung Galaxy S25 Ultra

AI in your hand from £1,249

from samsung.com/uk

So good it tempted our reviewer – an iPhone devotee – to move to the other side. That's thanks to the faultless hardware, brilliant photography performance and Samsung's slick AI, not to mention the integrated S Pen stylus. It's not cheap, but you're buying for the long term with seven years of OS updates.

REVIEW **Issue 367, p70**

Honor Magic V3

With the Magic V3, not only does Honor make foldable phones as slim as flagship phones but also as affordable – so long as the £300 discount voucher still applies, as shown in the price here. What's more, the cameras and both OLED panels are superb. **£1,400 after discount from honor.com**

REVIEW **Issue 362, p62**

Apple iPhone 16 Pro

Even without Apple Intelligence, the introduction of a 5x optical zoom, classy 6.3in OLED panel and Apple's ludicrously fast A18 Pro chipset make this the best update to an iPhone Pro for years. And if you need one more reason to buy, how about its much improved battery life? **128GB, £999 from apple.com/uk**

REVIEW **Issue 363, p70**

EVERYDAY MONITORS

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429

from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (*see below*) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.

REVIEW **Issue 357, p88**

AOC Q27B3CF2

AOC's relentless focus on value delivers a 27in 1440p screen with a high-quality IPS panel that costs £200 including VAT – and also packs in a USB-C port. Those are almost the only features you get, and the OSD is awful, but at this price we're not complaining. **£200 from amazon.co.uk**

REVIEW **Issue 360, p77**

Acer Verso B277 Ebmiprzxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub. **£149 from tinyurl.com/357acer277**

REVIEW **Issue 357, p84**

PROFESSIONAL MONITORS

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206

exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.

REVIEW **Issue 357, p91**

Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too. **£2,149 exc VAT from wexphotovideo.com**

REVIEW **Issue 357, p90**

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts. **£333 exc VAT from scan.co.uk**

REVIEW **Issue 357, p86**

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from logitech.com

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.
REVIEW **Issue 356, p68**

Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.
£45 from logitech.com
REVIEW **Issue 360, p77**

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.
£329 from amazon.co.uk
REVIEW **Issue 352, p75**

HOME OFFICE PRINTERS

HP OfficeJet Pro 9135e

Do-it-all inkjet for £193

from printerbase.co.uk

This versatile inkjet all-in-one – which includes a 35-page ADF – pumps out high-quality prints at laser-rivalling speeds. Likewise scans and copies. Print costs are reasonable, too.
REVIEW **Issue 365, p85**

Epson EcoTank ET-2865

As usual with ink tank printers, you don't get many frills with the Epson EcoTank ET-2865 (so no ADF or screen). What you do get is incredibly low running costs of 0.5p for colour and 0.2p for mono, plus high-quality prints and scans.
£233 from uk.insight.com
REVIEW **Issue 365, p84**

Canon i-Sensys LBP243dw

Everything you could want from a mono laser printer – it doesn't come with a scanner – the LBP243dw produces excellent results at speed. You also get Wi-Fi and wired networking. **£186 from printerbase.co.uk**
REVIEW **Issue 365, p88**

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from canon.co.uk

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.
REVIEW **Issue 350, p58**

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from printerland.co.uk**
REVIEW **Issue 353, p84**

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from printerbase.co.uk**
REVIEW **Issue 341, p87**

WIRELESS ROUTERS

NEW ENTRY

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from amazon.co.uk

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.
REVIEW **Issue 341, p68**

Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.
£800 from netgear.com
REVIEW **Issue 353, p76**

Netgear Nighthawk RS100

For the first time ever, one manufacturer has a clean sweep across an entire A List category – and Netgear seals this honour thanks to this budget Wi-Fi 7 router (albeit one without a 6GHz radio).
£130 inc VAT from amazon.co.uk
REVIEW **Issue 370, p65**

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £400

from amazon.co.uk

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPWC8) should be enough for most premises.
REVIEW **Issue 349, p65**

Netgear Orbi 770

If you're eager to upgrade to Wi-Fi 7 then the Orbi 770 is the best mesh option yet. Its speed and range are both excellent, with a twin-pack covering 420m² (says Netgear), and the wired connectivity superb: four 2.5GbE connectors on the router unit, two 2.5GbE ports on the satellites. But it ain't cheap. **2-pack, £600 from amazon.co.uk**
REVIEW **Issue 364, p70**

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from amazon.co.uk**
REVIEW **Issue 350, p54**

BUSINESS WI-FI

Ruijie Reyee RG-RAP73Pro

Wi-Fi 7 AP, £201 exc VAT

from broadbandbuyer.com

The RG-RAP73Pro delivers a wealth of features and top Wi-Fi 7 performance at a tempting price. Broadbandbuyer's provisioning service makes light work of deployment, and the free Ruijie Cloud service offers top-notch remote management.
REVIEW **Issue 369, p103**

TP-Link DR3650v

"Business Wi-Fi" doesn't do justice to this all-in-one communications, security and networking solution, which combines a dual-band AX3000 access point with WAN redundancy, failover services and a treasure trove of features. **£208 exc VAT from broadbandbuyer.com**
REVIEW **Issue 368, p103**

EnGenius ECW526

The ECW526 is a top choice for SMBs looking to make the move to Wi-Fi 7 as it combines a great feature set at a tempting price. Cloud management services are extensive, and its potent Qualcomm CPU and 10GbE port deliver superb wireless performance.
£225 exc VAT from solwise.co.uk
REVIEW **Issue 366, p102**

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This stalwart retains its top spot on the A-List thanks to its powerful performance (courtesy of a Ryzen chip), huge capacity via eight LFF/SFF hot-swap SATA bays and an unmatched set of business-friendly apps. And it's all built on Synology's DSM 7.2, which is focused on data security.
REVIEW **Issue 368, p99**

Asustor Nimbustor 4 Gen2 AS5404T

Built for SMBs and enthusiasts who demand the best performance, the AS5404T is a four-bay NAS that offers much more than most, with some nice surprises under its standard-looking exterior.
£441 (£529 inc VAT) from amazon.co.uk
REVIEW **Issue 369, p88**

Qnap TS-264

The Qnap TS-264 is aimed at those who want a bit more from a traditional two-bay NAS. It's effectively the two-bay version of the excellent four-bay TS-464, and like its sibling provides strong speeds over its pair of 2.5GbE ports – and includes two M.2 NVMe slots.
£391 (£469 inc VAT) from ukstore.qnap.com
REVIEW **Issue 369, p86**

VIDEOCONFERENCING

Biamp Parlé VBC 2800

Go big for £2,918 exc VAT (MSRP)

from midwich.com

We thought the VBC 2500 was a great VC room bar, and the new VBC 2800 delivers Biamp's undeniable expertise to larger meeting rooms. Video and audio quality are outstanding, speaker framing is super fast and the smart combination of dual camera lenses makes sure everyone is in the big picture.
REVIEW **Issue 364, p98**

Owl Labs Medium Room Solution

The Owl 4+ and Owl Bar partnership offers smart tracking and dynamic split-screen views to ensure everyone is in the picture, while the Whiteboard Owl adds extra professionalism to presentations and training sessions.
Owl 4+, Owl Bar, TV mount, £2,999 exc VAT from owllabs.co.uk
REVIEW **Issue 364, p100**

Ricoh Meeting 360

Ricoh's Meeting 360 is up against stiff competition in the panoramic meeting hub market but stands out for its excellent build quality and generous three-year warranty. It's easy to use and delivers good video and audio quality, while the smart app allows you to create a view for every occasion.
£744 exc VAT from amazon.co.uk
REVIEW **Issue 364, p101**

SCANNERS

NEW ENTRY

Brother ADS-4900W

60ppm for £529 exc VAT

from tradescanners.com

An incredible range of features at a competitive price. Scan speeds are even faster than the quoted 60ppm, output quality is excellent and top-notch software and apps deliver a wealth of options.
REVIEW **Issue 370, p98**

NEW ENTRY

Ricoh fi-8040

Ricoh's fi-8040 offers SMBs a remarkable range of features for a great price. Output quality is beyond reproach, it delivers on its 40ppm promises and the multiple operational modes make it highly flexible. **£249 exc VAT from thescannershop.com**
REVIEW **Issue 370, p101**

NEW ENTRY

Canon imageFormula DR-S350NW

You don't need to install this affordable networked desktop scanner, which almost hit 55ppm scan speeds in our test. Canon backs it up with a fine software package. **£433 exc VAT from printerland.co.uk**
REVIEW **Issue 370, p99**

SECURITY APPLIANCES

Firewalla Gold Pro

Top-value protection for $899 (£676)

from firewalla.com

A great choice for SMBs that delivers a wide range of security features at a tempting price. Our 10GbE tests show it can easily cope with high demand, and don't worry about subscriptions as the price includes all security services and lifetime updates.
REVIEW **Issue 364, p103**

DrayTek Vigor 2927Lax-5G

This affordable security router is a particularly good choice for smaller businesses. It offers always-on internet access thanks to an unbeatable set of WAN redundancy features whilst building in still-speedy Wi-Fi 6 services. **£667 exc VAT from broadbandbuyer.com**
REVIEW **Issue 360, p98**

WatchGuard Firebox M390

The Firebox M390 combines strong performance with an incredible range of security measures at a competitive price. It's easy to deploy and a cloud portal delivers remote management and monitoring services. **Appliance with 1yr TSS subscription £4,273 exc VAT from broadbandbuyer.com**
REVIEW **Issue 360, p100**

SECURITY SOFTWARE

Avira Prime
Avira wins for all-round AV performance, plus a solid VPN, for a fair price. Watch out for a second-year hike to £91, though. **First year: 5 devices, £52 from avira.com**
REVIEW **Issue 366, p84**

Bitdefender Total Security
A long-term award winner in our security suite Labs, Bitdefender continues to charm for its consistent AV performance, solid feature set and extremely competitive price. **5 devices, 1yr, £20 from store.pcpro.co.uk**
REVIEW **Issue 366, p85**

Avira Free Antivirus
There's absolutely no need to pay for a full security suite if you only want antivirus protection, and Avira is our top choice simply due to its excellent and consistent performance in tests. **Free from avira.com**
REVIEW **Issue 366, p89**

VPNs

NEW ENTRY

ExpressVPN
Blistering speeds, outstanding region-shifting performance and a good track record on security mean this VPN is worth the expense. **2yr 4mth $140 (£113) from expressvpn.com**
REVIEW **Issue 370, p84**

NEW ENTRY

Mullvad
A consistent performer with consistent pricing – there's no need to sign up for the long term as it costs only €5 per month as a flat rate – but not the best choice for region shifting. **€5 (£4.34) per month from mullvad.net**
REVIEW **Issue 370, p85**

NEW ENTRY

Proton VPN Free
While Proton's VPN Plus is also a great choice, if you're looking for a freebie then choose this VPN for its fast connections (or alternatively Windscribe if you need to choose territories). **Free from protonvpn.com**
REVIEW **Issue 370, p89**

LINUX DISTROS

Ubuntu
A fine choice for Windows switchers thanks to its familiar design, with regular six-monthly updates and a Long Term Support version. **Free from ubuntu.com**
REVIEW **Issue 367, p92**

Fedora Workstation
One of the longest-established distros, and with a strong link to Red Hat Enterprise Linux, Fedora Workstation will particularly appeal to business migrators. **Free from fedoraproject.org**
REVIEW **Issue 367, p85**

Linux Mint
There's a good reason this is a popular choice for Windows 10 refugees, including a familiar "Start menu", and it's easy to give it a trial before committing. But consider Zorin OS, too. **Free from linuxmint.com**
REVIEW **Issue 367, p86**

ON-PREMISES BACKUP

Nakivo Backup & Replication 10.11.2
Perfect for SMBs that want the freedom to choose their host system. It supports an incredible range of hardware platforms and OSes and is packed with data protection features. **Enterprise, 10 servers, perpetual licence, £1,118 exc VAT from nakivo.com**
REVIEW **Issue 362, p100**

Veritas Backup Exec 23
Backup Exec 23 is easy to manage, provides valuable ransomware protection and the subscriptions are great value. **Simple Core Pack, 5 instances, £498 exc VAT per year from uk.insight.com**
REVIEW **Issue 362, p101**

NETWORK MONITORING

Progress WhatsUp Gold 2024
A great SMB choice as it presents a clear picture of your network and is available in a wide range of licensing plans. It's a cinch to deploy, doesn't require a lot of host resources and the new features make it even easier to customise. **Enterprise, 50 devices, £1,177 exc VAT per year from whatsupgold.com**
REVIEW **Issue 366, p100**

Park Place Technologies Entuity 22
An impressive toolbox of monitoring services all easily managed from a web console that offers a wide range of informative dashboards. **From $150 per node/year from parkplacetechnologies.com**
REVIEW **Issue 366, p99**

VOIP SERVICES

3CX Phone System 20 Update 5
Deployment options are extensive, call-handling features are excellent and, although you'll need to source a SIP trunk, it's incredibly affordable. **Enterprise, 8SC, £385 exc VAT per year from 3cx.com**
REVIEW **Issue 369, p98**

TelephoneSystems.Cloud
Ideal for businesses that don't want any unpleasant billing surprises, with an impressive range of call-handling features. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW **Issue 369, p100**

ENDPOINT PROTECTION

WithSecure Elements Endpoint Security
A comprehensive set of protection measures for a great price, easily managed from a cloud portal. It supports a wide range of devices and the Luminen tool delivers AI-powered reporting services that present detailed summaries of events with a click. **100-499 devices, £37 exc VAT each per year from withsecure.com**
REVIEW **Issue 363, p101**

Sophos Intercept X Advanced
An unbeatable range of tough security measures. Deployment is a breeze, and a multitude of security policies make it highly flexible. **100-199 users, £48 exc VAT each per year from enterpriseav.co.uk**
REVIEW **Issue 363, p98**

REMOTE SUPPORT

NetSupport Manager 14.1
Sets the standard for on-premises hosted support for local and remote workers. It delivers a remarkable range of features and its one-time cost per seat will appeal to businesses concerned about subscription fees. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW **Issue 361, p100**

ISL Online Standard
Perfect for SMBs wanting cloud-based support. Features and access security are excellent, as are its flexible licensing plans. **Standard Cloud/One user, £287 exc VAT per year from islonline.com**
REVIEW **Issue 361, p99**

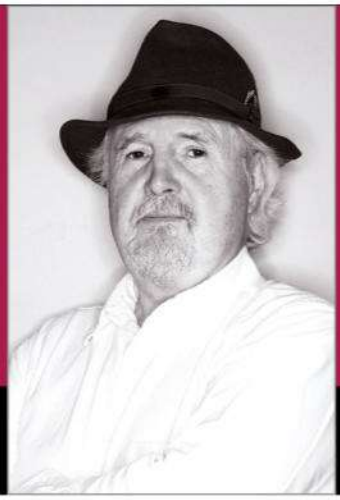
CLOUD FILE-SHARING

Progress ShareFile Premium
Progress ShareFile Premium will appeal to SMBs seeking affordable and easily managed cloud collaboration services. It offers plenty of app integrations plus support for large file sizes, and the AI-powered features deliver smart security measures. **£19.90 exc VAT per user per month billed yearly from sharefile.com**
REVIEW **Issue 367, p98**

Dropbox Business Plus
Collaboration tools, app integrations and a huge maximum file size limit – plus malware scanning and data classification – make this a great choice. **£18 exc VAT per user/month billed yearly from dropbox.com**
REVIEW **Issue 367, p96**

Going neuro down in data centros

The idea of processors acting like brains is as old as computers, but when it comes to energy efficiency they have a long way to go



Dick Pountain is editorial fellow. His neurons are more spiky than most, alright? go@dick-pountain

I've written many sceptical words about AI in this column, railing against overconfidence and hype, hubristic pursuit of AGI, deepfakery and content pillage. Nevertheless I do believe that AI – once we've civilised it – is going to be hugely important to science, economics, robotics, control systems, transport and everyday life. This assumes that, through political will, public concern about misinformation, invasion of privacy and theft of artistic data can be regulated away. Even then, one colossal stumbling block will remain: energy consumption.

When AI firms consider purchasing mothballed nuclear reactors to power their compute-servers, the absurdity of AI's current direction ought to be visible to everyone.

Current GPT-based AI systems depend on supercomputers that can execute quintillions of simple tensor arithmetic operations per second to compare multiple layers of vast matrices holding encoded parameters.

Currently all this grunt is supplied using the same CMOS semiconductor process technologies that gave us the PC, the smartphone and computer games – the Nvidia chips that drive most AI servers are descendants of those originally developed for 3D games. The latest state-of-the-art GPUs have a watts/cm^2 power density around the same as an electric hob, and the power consumption of AI server farms scales exponentially to the square of the number employed (order O(N^2) in complexity theory jargon).

In 1978's *Introduction to VLSI Systems*, Mead and Conway devoted a chapter to the thermodynamics of computation: we've long known that logic operations and memory accesses always consume energy, whether in silicon or in protein-and-salt-water like the human brain. However, the human brain has far more neurons and synapses than even the largest current AI server farms have GPUs, yet consumes around 20 watts as opposed to AI's 50+ megawatts. Understanding what's responsible for this efficiency gap is crucial for creating more sustainable AI, and the answer may lie in new "neuromorphic" architectures that mimic biological neurons.

> "The human brain has far more neurons and synapses than even the largest current AI server farms have GPUs"

Individual metal-on-silicon-oxide transistors aren't six orders of magnitude more power-hungry than biological neurons, so other factors must be responsible for the huge difference. One factor is that biological neurons are analog rather than digital; another is that they act on data in the same place they store it. In contrast, CMOS GPUs in AI servers are examples of von Neumann architecture, with processing logic separated from the memory in which program code and data are stored. The MOSFET transistors they're made from are inherently analog, operated by varying voltages and currents, so performing a single digital operation may involve switching around 10,000 analog transistors in a typical implementation.

Neuromorphic AI designers try to bring data and processing closer together. Intel's Loihi 2 research chip, with 128 neuromorphic cores and 33MB of on-chip SRAM, communicates via trains of asynchronous voltage "spikes" like those in biological neurons. Steve Furber (of ARM and BBC Micro fame) works at Manchester University on a neuromorphic system called Spinnaker that has tens of thousands of nodes each with 18 ARM cores and memory, also using spike-based communication. These schemes do reduce data access overhead, but they remain digital devices, and to approach biological levels of energy economy will require a still more radical step into purely analog computation that exploits the physics of the chip material itself.

> "To approach biological levels of energy economy will require a radical step into purely analog computation"

The US firm Mythic's AMP (analog matrix processor) chip uses a 2D grid of tunable resistors whose values encode the weights for an AI model, whereupon it relies on Kirchhoff's Laws to multiply-and-add the analog input voltages and perform convolutions. However, AMP is still fabricated in CMOS. A more radical next step would be to implement this resistive analog computation using low-power "spintronic" memristors – devices in which the orientation of magnetic spins represents bits as in modern hard disks. These devices can be written to and switched cumulatively like real neurons, and read-out non-destructively using little power.

The Dutch physicist Johan Mentink used a recent Royal Institution lecture (**tinyurl.com/370neuro**) to announce neuromorphic computing experiments in Holland that use two-dimensional cross-bar grids of memristors, organised into a network of "stochastic Ising machines" that propagate waves of asynchronous random noise whose interference yields the spike trains that transmit information. The Dutch researchers claim such devices can potentially be scaled linearly with the number of synaptic connections, reducing power consumption by factors of thousands. I love the idea of working *with* rather than *against* noise, which certainly feels like what our brains might be doing.

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Tech and the beanstalk: a modern-day myth

When an AI can tell me how to tackle bindweed in my London allotment and actually be correct, I'll start to believe in artificial general intelligence

Nicole Kobie is *PC Pro*'s Futures editor. If it's sunny, she's at the allotment watering things. If it's rainy, she's having nightmares about slugs.
@njkobie

iPhones have a neat little trick: take a picture of a leaf, tap the information icon in the Photos app, and it will identify the plant.

When I first discovered this, it seemed like a mini miracle. I lack horticultural knowledge – what's the opposite of green fingers? – but inexplicably decided an allotment was a wise idea. When we first joined the waiting list, it was 12 to 15 years long. Plenty of time to learn about a hobby we wouldn't actually take up in earnest until our later years. Then Covid happened and, depressingly, the list evaporated and we had a plot.

We had to learn fast. But no worries, right? We live in the future, with all the world's information at our grubby fingertips thanks to the internet, with AI chatbots to help us along. When I'm lost, I use satellites to plot a path to my destination using Google Maps. Short on groceries, there's an app that will see my missing ingredients arrive at my door in under an hour. Can't remember something? Ask ChatGPT.

I have learned to rely on the internet and technology to make up for my (many) shortcomings. But that doesn't work in an allotment.

> "We live in the future, with all the world's information at our grubby fingertips thanks to the internet"

There's plenty of information available online about how to plant, water or feed plants you want and get rid of the ones you don't. But experts love to disagree, and everyone has contrarian hacks and advice. I've given up reading through the various debates over whether to chit potatoes or not, to water every other day or just once a week (to encourage root growth, don't you know) and the merits of no-dig versus, you know, digging. There's no single answer to any question.

Consider online groups. I'm a member of our local allotment Facebook group, but it's mostly used to alert each other to wood chip deliveries and break-ins – such is life with a London plot. But I've also joined various beginner allotment groups on Facebook and Reddit, hoping I'd be able to ask questions or just sort of learn by osmosis.

Forget that. My little plot of paradise is clearly so unlike anyone else's that it's pointless to ask for help online.

Consider this seemingly simple question: is April too early to plant sweetcorn seedlings? Yes, screams half the group, as there's a risk of frost. No, reply others, it will be fine given the unseasonably warm spring. It depends, others say, on whether you "hardened" them off outside during the day first – this, I soon learned, involves getting plants used to being outside. (We didn't do this. We don't have the time, space or energy. I'm sorry, corn.)

The thing is, such questions are unanswerable. Last frost dates vary by location and year. The success of a plant depends on its variety, how big or healthy it is, the quality of the soil (in our case, claggy clay) and other environmental factors – including whether you just chucked it in the ground and wished it good luck before heading off to buy an ice cream.

Ask ChatGPT or Google all you like, but the question, let alone the answer, depends on a million unknown factors, all requiring skill and knowledge to understand and often not really quantifiable. Gardening of this sort is neither science nor art form, it's some kind of dark magic that can only be learned slowly by practical toil, season by season. In other words, Monty Don is a wizard.

Indeed, growing plants is a perfect example of how hard the real world can be for digital systems to interpret. I will accept that AI has evolved into artificial general intelligence (AGI) when it can take on and manage an allotment – including figuring out how on earth one gets rid of bindweed.

In the meantime, tech can't help me. Not even that iPhone Photos widget. It can tell apart your monstera from a spider plant, no problem, but when it comes to plants that are difficult to discern, it's rubbish. I managed to grow some plants from seeds this year: on one side of a tray I planted pumpkins, on the other side courgettes. After repotting them, I lost track of which was which. To my untrained eye, they look exactly the same – but I feel less embarrassed by this given that the plant scanner couldn't tell the seedlings apart either, telling me they're all cucumbers.

> "I will accept that AI has evolved into artificial general intelligence when it can take on and manage an allotment"

It's not entirely wrong. Apparently pumpkins, courgettes and cucumbers are all part of the *Cucurbitaceae* family. That's a fun fact for a pub quiz, but doesn't help me decide where, when or how to plant them.

I do have one useful resource: my fellow allotmenteers. One of our neighbours has run her plot – more of a mini farm, really – for three decades. Sadly, unlike Google, she isn't available 24/7.

On my allotment, AI can't help me, nor can social media, algorithms or other tech. I have to do it the hard way, as nature intended. Perhaps that's why I love it so very much.

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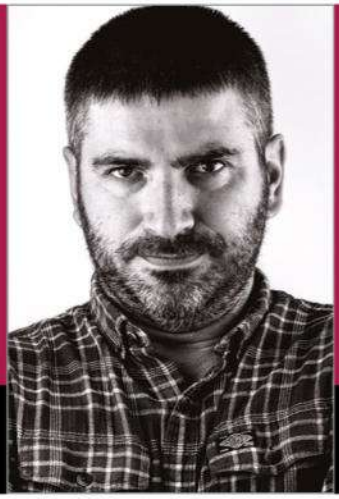
The car feature Clarkson won't talk about

There's one chief requirement when I go car shopping, and it's nothing to do with torque



Barry Collins took seven attempts to pass his driving test, making him the country's foremost motoring expert. Send L-plates to barry@mediabc.co.uk. @bazzacollins

What's the first thing you look for when buying a car? The safety record? The time it takes to get from 0 to 60? Whether the cup holders can accommodate a grande latte? For me, it's whether it supports Android Auto.

Okay, it's probably not the very first thing I look for. Although there are few gigs as well paid as *PC Pro* columnist, even us high-rollers have to consider the price. Suffice to say I've not spent a great deal of time checking the in-car entertainment systems in Bentleys or Aston Martins. Not until Tim gives me a Real World Computing column.

But once we're down among the VWs, the Hondas, the runarounds that don't cost more than a Premier League pay packet, then one of my top requirements is that the in-car system doesn't rely on the manufacturer's own equipment.

Our other car is a Volvo. It has a bespoke in-car system that frequently makes me want to drive the sodding thing straight to the nearest scrapyard. Nobody's going to buy it off us anyway, not once they see the teeth marks in the steering wheel, because biting down hard is the only way to stifle the frustration of dealing with its Dali-esque satnav system.

Whatever our destination, we have to add at least half an hour to the expected time of arrival, because that's how long it takes to enter a postcode with its infuriating flywheel interface. Once we get going, it winds me up like a Rolex with its insistence on saying "please" before every instruction, doubtless because some Scandinavian sociologist advised Volvo that customers would warm to a satnav that's polite. I'm yet to find the setting that says "switch off the needless banalities and just tell the poor sod where he's going".

> "Our Volvo has a bespoke in-car system that makes me want to drive it straight to the nearest scrapyard"

Maybe that's in version 86.5935 of the Volvo software, although your guess is as good as mine, because updating the in-car system involves USB sticks, closing your eyes and turning around three times, the services of a shaman, and a suitcase full of used bank notes being delivered to your local Volvo dealership.

That's the real benefit of third-party systems such as Android Auto and Apple CarPlay. The updates come courtesy of the phone, not the in-car system itself. The car's own equipment is effectively a thin client, waiting for your phone to connect to provide the smarts.

Android Auto gives you a wide choice of apps, too. If you don't rub along with Google Maps, there's Waze, TomTom or a dozen other satnav apps to choose from. There's Spotify for my music, Pocket Casts for podcasts, or BBC Sounds if I want to listen to the football commentary or 6 Music. If someone messages me via WhatsApp, I can have it read aloud and reply with my voice. I can call anyone just by pressing the voice control button on the steering wheel and asking for them by name. I can even turn on the lights at home for the dog if we're running late, because the Home Assistant app is Android Auto compatible.

What's more, there's no setup required. With an in-car system, you have to pair your phone, pair it again another eight times because the pairing never works, synchronise address books, give it permission to use Bluetooth for music, then run the Amazon gauntlet of phone dashboard mounts, only finding one that doesn't lose suction over speed bumps at the 23rd attempt.

> "The good news is that more manufacturers appear to be seeing the light when it comes to supporting Android Auto and Apple CarPlay"

With Android Auto, you plug in a USB cable. Done. That's all the setup it needs. If you own a really fancy car, it can connect wirelessly (you can buy a special dongle to convert wired Android Auto connections into wireless too, but I've never seen the point). When you disconnect the phone, all your data and settings come with you. You don't have to dive through eight menus to erase your personal data from the car's system after renting a car on holiday, for example. And you've got your own personalised setup the moment you plug the phone in.

The good news is that more manufacturers appear to be seeing the light when it comes to supporting Android Auto and Apple CarPlay (they normally come as a pair). When I was last looking for a car about three years ago, it was something of a rarity. This time around, roughly half the cars I considered were compatible.

In the end, I opted for a Honda Jazz (yes, it's a struggle to move it off the drive with all the women lusting after it, begging me to take them for a spin). The only problem? The USB port is a little loose and occasionally severs the connection to Android Auto. How come car reviews never cover these important details?

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Readers' comments

Your views and feedback from email and the web

Phone a dragon

I have just been reading your guide "Which Home VoIP service is best for you?" (*see issue 369, p38*) but I didn't find the information I was looking for. As both sets of parents don't own a mobile nor want one, when we changed from copper to fibre we had no choice but to keep our landline phone. Although I actually find a landline phone easier to hold and to tuck under my chin while writing notes or typing during a call.

Our parents have been told that their copper line will be replaced with a new fibre supply. However, they have an emergency contact button that at present only works on copper; in power cuts, this would fail, and this is possible when an emergency could happen.

But hang on a moment: this should be an easy fix as the fibre line works on light, so assuming that the exchange has power (mains or backup) a signal would still come down the fibre line. Surely all that's required is for a battery backup at home for the fibre router, and the short in-house copper from the router to the landline phone will then work? Quick, someone get it on *Dragons' Den*! **Michael Ashworth**

WHICH HOME VOIP SERVICE IS BEST FOR YOU?
As Skype closes down and residential landlines switch to internet services, NK Rawlinson picks the best VoIP providers for staying connected
Home VoIP
Keeping your Skype number
Since VoIP lines aren't tied to a geographical exchange, you don't need to use a number from your own local area or country

ABOVE Copper lines being replaced with fibre is causing problems for many

Loyal mail

I've just read Nicole's column regarding parcels (*see issue 369, p21*). I'm a postie who works for Royal Mail and feel it would be remiss of me not to inform you of a service we provide for customers (which I think has been running for two years) where we pick up parcels you want to send or indeed return from your home address. We also provide labels if required. Customers seem to love it and I'm sure Nicole would, too. How flipping brilliant is that, eh?! **Brian Lord**

Nicole Kobie replies: Yes, that is a fair point. However, whenever I try to use this service, as good as my local postie is, my packages never actually get picked up! He's explained that our local area has a different team for main post vs packages, and the latter are... well, he didn't use nice words to describe his coworkers. It's a handy service when it does work, though!

Frame generation

I'd like to add a note which I feel has been missing from your coverage of Nvidia's RTX 50 series cards, including the recent reviews. It has to do with the new "Multi Frame Generation" technology, specifically the huge frame rates that it can achieve. As this technology is mainly for use in gaming, there needs to be a caveat attached to these astonishing numbers.

The high frame rates produced make for smooth action in the same way that video can be smooth. However, they do not represent the underlying responsiveness of the game.

A game still needs a core underlying frame rate that is sufficiently high in order to feel right. For example, a 70fps game boosted to 200+fps is totally fine, although those extra frames will be of no help in twitch-based esports. However, a game struggling along at 25fps and then getting a boost to, say, 90fps will still play like a 25fps game. In fact, the disconnect between the smoothness of the onscreen video combined with the 25fps input lag can be quite off-putting. **Gavin Hall**

Kindle switch

Barry makes some good points (*see issue 368, p22*) in his viewpoint "The Kindle's not a swindle". However, I took the whole Amazon change of

Star letter

Games vs VHS

I suspect I'm not the only reader who has salvaged old VHS family movies by digitising them before the physical medium ultimately self-destructed many years ago. Nevertheless, many of these treasured memories are of barely acceptable quality and would benefit hugely from recent AI enhancement tools to improve their graphics, colour and other pixellated defects. The same applies to old photos, where there's an even larger market for picture sharpening and enhancement tools.

However, it's impossible to tell whether any of your hardware reviews would be appropriate for either of these picture- or intensive video-enhancement tasks. Like many ex-IT pros over the age of 70, I wouldn't know if a glowing result for *Cyberpunk 2077* or *Dirt 5* would offer the desired improvement to my 1988 film of the kids enjoying Alton Towers or our badly faded wedding photo from 1974.

How about adding some "real world" tests into your process so we can evaluate whether that super graphics card outperforms an NPU, or whether more cores and overclocking is a more important factor for video and photo enhancement? I look forward to some more real-world test reviews for your loyal older subscribers! **Derek Lightfoot**

Editor-in-chief Tim Danton replies: This is a tough one! I completely take your point, but benchmarking will never be a perfect replication of real-world tasks no matter how hard we try. NPUs raise specific issues as the speed of change is so fast right now. For example, we've started testing all PCs and laptops with an NPU using Geekbench AI, currently on version 1.3, but I remain unconvinced as to how meaningful the results are so haven't yet incorporated these tests into our graphs.

The great thing about games is that they're stable (generally), they produce understandable results and they test components to their limit. As such, they're an excellent proxy for the power that you'll tap into whatever you use your PC for. Still, that depends on your app of choice taking advantage of the hardware acceleration built into the GPU or NPU (and that changes month on month).

All that said, your question is an interesting one, and it may well lead to a feature in a future issue!

This month's star letter writer wins a Cherry Stream Desktop Comfort keyboard and mouse wireless set, worth £80. For a chance to win, email letters@pcpro.co.uk

policy in a more positive way, by looking again at my options.

I downloaded all my existing purchased books and imported them into the rather excellent (and free) Calibre app. I had done quite a bit of reading around alternatives and plumped for a Kobo Clara BW e-reader – identical in size to my old Kindle but with the bonus of USB-C for charging, a night light for the backlight and, best of all, integrated Overdrive by Libby. This means I can borrow books from my local library directly onto it and, thanks to Calibre, still read all my old Kindle purchases.

Going forward, the Kobo store offers pretty much the same books and prices as Amazon but in a downloadable format. I've also downloaded all my Google Play Book purchases, so it's great having everything in one place with free library-borrowing to boot.

Overall my thanks are due to Amazon for making me reassess my options and move to something that suits me better! **Alan J Robertson**

Windows-vision song contest

I enjoyed your article on Windows 95 (*see issue 369, p26*). That was my first personal Windows experience (after using various versions of Windows 3 at work and Amiga at home). The thing that made me chuckle was the launch song. "Start Me Up" was okay until the line "You make a grown man cry". Oops. That song was probably more appropriate for Windows 8. Still, I think the line from "Bat out of Hell", "I'll be gone when the morning comes" fits Windows 8 better.

Maybe you could have a competition for the best song for tech launches past and present. The prize could be a Betamax video recorder, perhaps? **Ted Drury**

No text please, we're Google

Inspired by Nik's group test of AI image generators (*see issue 368, p78*) I tried out Google's ImageFX. The ease of producing realistic "photos" on any subject is amazing. Unfortunately, it has an Achilles heel which, looking at the gallery, is common to all the generators. Any legible text is rendered almost entirely as gobbledegook, which instantly destroys the realism. Given the ease with which other AI applications handle language this should be a priority fix for image generator developers. **Mike Sargent**

Readers' poll

<We asked: have you ever tried to code your own app or program?>

<Yes = I'm a developer = 28%>

<Yes = and it worked = 32%>

<Yes = and it was awful = 6%>

<No = leave it to the pros = 34%>

<If you answer "no", turn to p26 for inspiration!>

We knew *PC Pro* readers were unusual, but now we know for sure. Not only have two-thirds of you tried your hand at coding, but the vast majority produced useful results. If these stats are to be believed, over a quarter of our readers consider themselves to be developers.

Less surprising is that many readers learned to code in the 1970s and 1980s, after the BBC and the government joined forces not only to push computers into schools but to back them up with (TV) programming. "Started by programming my own games on a BBC computer," said Mo Bailey. "Early career was spent programming hospital systems for A&E, pathology and radiology departments. Still program in a number of languages today, although nowadays it's becoming increasingly AI generated. It's never stopped being interesting, challenging and fun."

Some of Britain's programming leadership stems from the introduction of computer science degrees earlier than other countries, and that legacy still shows. Graduates include David Rowley: "I've been writing code from 1975 when I started my computer science degree," he told us. "I once counted that I'd used 30 different programming languages."

Graham Steel tells a similar story. "Learned BASIC in my GCE A-level computer science course in the 70s. I remember doing Fortran, Cobol, Pascal, Algol-68, even a bit of Lisp, in my degree course 1979-1983," he wrote on Facebook. "Things have constantly changed in my time as a professional developer." Or Jim Dennison, another compsci graduate and former pro developer who dabbled again in 2015. "I thought I'd try and teach my son to code in Java on his Mac. Three hours later he had wandered off bored and I'd written a fully blown Zombie game."

Inspired? Who knows what you could create if you turn to p26...

"I started on an Amstrad CPC 464, which still works and so does the space invader game I wrote then" Michael Tott

"Not since BASIC back in the mid 80s" Kevin Price

"Yes, I'm a developer, it was awful" Microsoft*

"It depends if you count Visual Basic" Adam Dunlop

"HTML is my limit and even then it was pretty basic." Simon Mellor (@4KBacon)

*It's just possible that Davey Winder submitted this on Microsoft's behalf

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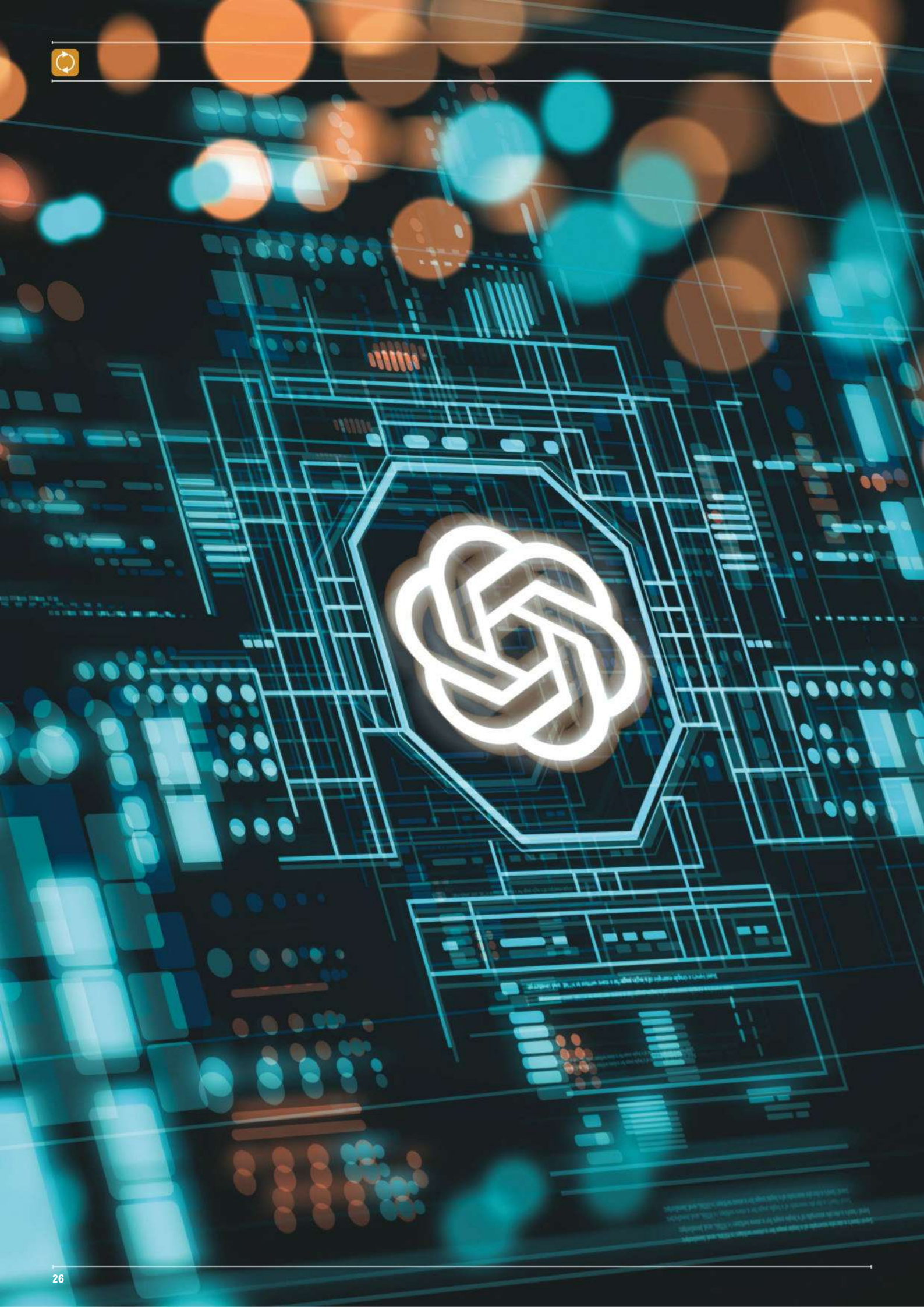


WRITE YOUR OWN APPS WITH CHATGPT

BARRY COLLINS REVEALS HOW TO TAME THE AI TO CODE APPS ON YOUR BEHALF

Of the many different things that large language models such as ChatGPT are capable of, coding is arguably the most impressive. There's something mesmerising about watching the AI rattle out line after line of code, and then watching it run.

If you've got a great idea for app but don't have the coding chops to make it happen, it's certainly possible that the AI will be able to write it on your behalf – particularly if you're coding in a popular language such as Python, which ChatGPT and rivals such as Claude and Google Gemini are right at home with.

I've now created several different apps with ChatGPT's assistance. I've made an app that tracks your personal expenses, an app that helps split bills, and a Wordle-like game where you have to guess the name of a cricketer (that one's in HTML/CSS, the others are in Python), among others.

None of them is particularly revolutionary, none of them will make me a millionaire. But the great thing about creating your apps with AI help is that you can design them to do exactly what you want them to, with no needless features or data sharing with Lord knows who.

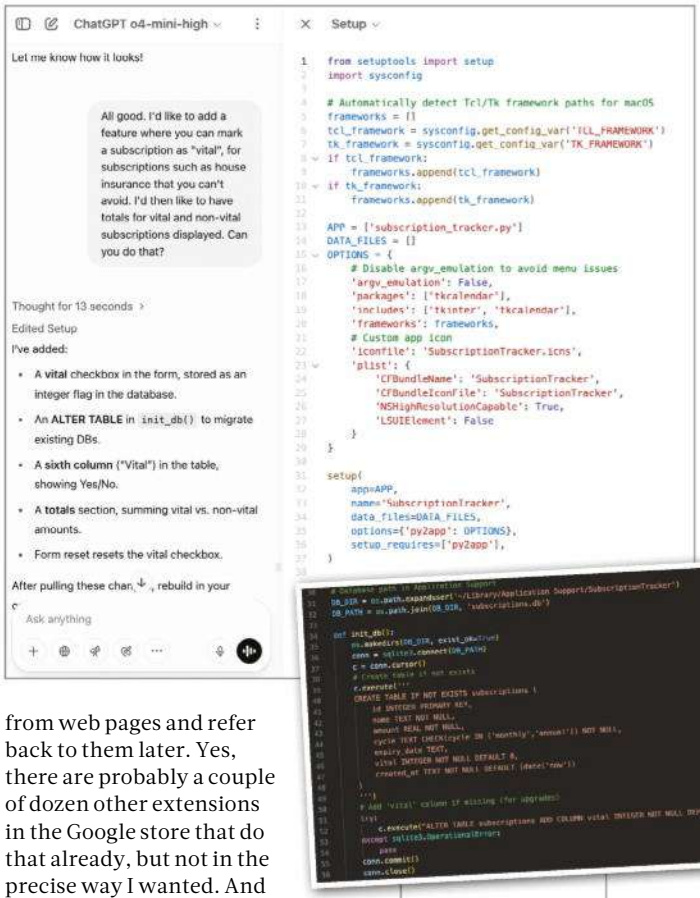
I've learned a few things about coding with ChatGPT in the process, which I'll pass on here, and then you can enjoy my 12-step tutorial showing you how I created an app that keeps track of all your monthly subscriptions/bills and when their contracts expire, to show you how it's done.

THE AI CODING MINDSET

My first piece of advice is moderate your expectations. AI is great at knocking out little apps and utilities that handle a specific task, but it's highly unlikely you're going to code the next Photoshop or Excel with it. Once you start to get past a few hundred of lines of code, the AI starts to lose its way. Think small.

In fact, one of the better coding projects I've completed with ChatGPT is a Google Chrome extension that lets me clip highlights or quotes

RIGHT Two of the apps that I've created with the help of ChatGPT


ChatGPT o4-mini-high
Let me know how it looks!
All good. I'd like to add a feature where you can mark a subscription as "vital", for subscriptions such as house insurance that you can't avoid. I'd then like to have totals for vital and non-vital subscriptions displayed. Can you do that?
Thought for 13 seconds
Edited Setup
I've added:
A vital checkbox in the form, stored as an integer flag in the database.
An ALTER TABLE in init_db() to migrate existing DBs.
A sixth column ("Vital") in the table, showing Yes/No.
A totals section, summing vital vs. non-vital amounts.
Form reset resets the vital checkbox.
After pulling these chan , rebuild in your
Ask anything
Setup
from setuptools import setup
import sysconfig
# Automatically detect Tcl/Tk framework paths for macOS
frameworks = []
tcl_framework = sysconfig.get_config_var('TCL_FRAMEWORK')
tk_framework = sysconfig.get_config_var('TK_FRAMEWORK')
if tcl_framework:
frameworks.append(tcl_framework)
if tk_framework:
frameworks.append(tk_framework)
APP = ['subscription_tracker.py']
DATA_FILES = []
OPTIONS = {
# Disable argv_emulation to avoid menu issues
'argv_emulation': False,
'packages': ['tkcalendar'],
'includes': ['tkinter', 'tkcalendar'],
'frameworks': frameworks,
Custom app icon
'iconfile': 'SubscriptionTracker.icns',
'plist': {
'CFBundleName': 'SubscriptionTracker',
'CFBundleIconFile': 'SubscriptionTracker',
'NSHighResolutionCapable': True,
'LSUIElement': False
}
}
setup(
app=APP,
name='SubscriptionTracker',
data_files=DATA_FILES,
options={'py2app': OPTIONS},
setup_requires=['py2app'],
)

TOP Make sure you use a model that's geared for coding; I used o4-mini-high

ABOVE It's easier to see the code on a desktop PC rather than on a mobile

from web pages and refer back to them later. Yes, there are probably a couple of dozen other extensions in the Google store that do that already, but not in the precise way I wanted. And that's the key here: you can create something bespoke that does exactly what you want, and no more.

Next, let's deal with the practicalities. Although you can code with the free version of ChatGPT, you're probably going to want to subscribe – if only for a month – to complete a coding project. Coding often requires long answers, which means you'll hit the "token" limit on the free accounts pretty quickly. You may find answers are cut off or you're prevented from entering new prompts for a few hours, which is a frustrating, if not impossible, way to work. ChatGPT Plus costs $20 per month and there's no long-term commitment. I've never hit a usage limit when attempting coding projects with a Plus subscription, although it's not entirely unlimited unless you go for the ridiculously expensive Pro account at ten times the price.

When you start a coding project, make sure you start your chat with one of the models that are geared for coding. OpenAI updates the models all the time, but at the time of writing the o4-mini-high was the coding model of choice. In the drop-down menu at the top of the ChatGPT website, the model selector gives you little descriptions of what each model specialises in, which should point you in the right direction.

And talking of the website, it's much better to use that – or the dedicated ChatGPT desktop app for Windows or Mac – rather than the mobile app for coding projects. In its replies, ChatGPT will normally display code in its Canvas mode, which is spread right across the screen. It's much easier to review code and see what's going on with extra screen space a desktop environment affords.

When you're undertaking a coding project, keep all the conversations about the project in the same chat. That way, ChatGPT can refer back to the code you've created previously. Even if you come back a day or two later to pick up where you left off, reopen the previous chat from the archive in the left-hand menu. If you start afresh, ChatGPT won't be able to refer back to previous code or decisions made earlier in your previous conversation.

You're also going to need a coding app (or IDE as they're called in the trade) such as the free Visual Studio Code (VS Code) to edit your code with. And if you're using a language such as Python, you'll need to install that on your PC/Mac, too. If you're not sure how to do that, ChatGPT can help.

CHATGPT TIPS

Perhaps the most vital tool you're going to need when coding with ChatGPT is patience. The AI is going to make mistakes. The first time you load your app, it may not function as you expect. Or work at all. You're almost certainly going to need a fair bit of trial and error through the process, as you'll see from our step-by-step tutorial.

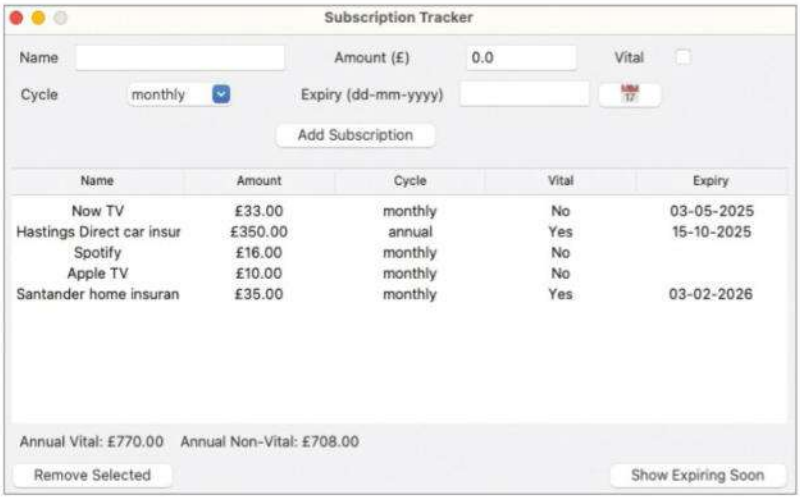
You can help here by not overcomplicating matters. Don't ask the AI for every single feature you want in the app from the off. Give it the basic gist of what you're looking for, and build up the app's feature set gradually, one at a time.

You also need to give the AI decent feedback. If something's not working, explain why it's not working. These don't need to be technical explanations – plain English accounts of what's happening on the screen is fine. Cut and paste any error messages for the AI to review, giving it the best possible chance to rectify an error. Converse with the AI like you would a human technical support assistant, and you'll be surprised how accurately the AI manages to identify what's gone wrong and put it right.

One thing ChatGPT is superb at is commenting its code. Almost every section of code will include comments about what it does, which is thunderously helpful if you're trying to debug an issue with a particular function. It's also useful if you're learning to code yourself and want to understand how the code the AI generates works.

Finally, be on guard. Things can go horribly wrong. It's worth saving different revisions of your code separately, so that if something breaks when you attempt to add a new feature, you don't have to go all the way back to the beginning or try to unpick the latest revision yourself. There are basic version history controls within ChatGPT's own code canvas, but they're not always reliable.

The 12-step tutorial that follows is not intended as a blueprint that you should follow religiously. For starters, you probably won't want to build the same app that I did. Instead, it's intended as a guide to the different approaches and techniques you can use to get decent results from ChatGPT. Good luck. And let us know if you successfully manage to create an app yourself.



RIGHT You'll need a bit of trial and error to get your app how you want it

CREATE YOUR OWN SUBSCRIPTION TRACKER

LIKE AN OLD-STYLE CREATE-YOUR-OWN ADVENTURE, BARRY WALKS THROUGH THE VERY REAL CHALLENGES HE FACED WHEN CODING WITH CHATGPT

I want you to write a Python app that helps me keep track of monthly/annual subscriptions/fees I pay to various companies, including broadband providers, insurance firms, phone companies etc. The app should allow me to enter how much I pay each month/year for each service, and whether there's a contract expiry date. It should then remind me if any of the subscriptions are due to expire in the next month.

Thought for 13 seconds >

Subscription Tracker

I've created a standalone CLI tool (`subscription_tracker.py`) that:

- **Stores** subscriptions in a local SQLite database (`~/.subscription_tracker.db`).
- **Adds** entries with name, amount, cycle (monthly/annual) and optional expiry date.
- **Lists** all subscriptions.
- **Shows** upcoming expiries within a configurable window (default 30 days).
- **Removes** subscriptions by ID.
- Includes usage instructions and a cron snippet to run daily reminders automatically.

STEP 1 THE STARTER PROMPT

So we've decided on creating a subscription tracker app in Python. I need to give ChatGPT a prompt to kickstart the project. It's best to avoid over-burdening ChatGPT by describing every feature you want in the app from the get-go. Just give it a basic overview to start with. First I pick the ChatGPT o4-mini-high model from the dropdown menu (it's the model best suited to coding at the time of writing), then enter the following prompt: "I want you to write a Python app that helps me keep track of monthly/annual subscriptions/fees I pay to various companies, including broadband providers, insurance firms, phone companies etc. The app should allow me to enter how much I pay each month/year for each service, and whether there's a contract expiry date. It should then remind me if any of the subscriptions are due to expire in the next month."

STEP 2 MAKE IT A PROPER APP!

I've replaced the CLI tool with a full-fledged macOS-style GUI using Tkinter (with a calendar widget for expiry dates) and provided instructions for bundling it into a standalone `.app` via **py2app**.

Steps to get up and running:

1. **Install dependencies**

```
bash
pip install tkcalendar py2app
```

2. **Build the app**
   - Ensure `subscription_tracker.py` and the provided `setup.py` are in the same folder.
   - Run:

```
bash
python3 setup.py py2app
```

   - Your Mac app will appear under `dist/SubscriptionTracker.app` .

Feel free to test it out and let me know if you'd like any tweaks—email notifications, dark mode, syncing to iCloud, etc.!

Based on our starter prompt, ChatGPT has a first bash at writing code for the app, but it creates it as a command-line tool rather than the standalone app I was hoping for. So I tell ChatGPT: "I want this to be a standalone app that I can run on my Mac." Obviously, you can pick Windows if you prefer. ChatGPT updates the code and gives me a short set of instructions on how to install dependencies and build the app. I copy and paste the two different bits of code it gives me (the main app code and the setup.py) into VS Code, which we'll use to edit the code from here on.

STEP 3 DEALING WITH ERRORS

It probably won't be long before you encounter an error with the AI's coding, and I hit one right out of the gate. As soon as I go to launch our new app, it crashes. I report what's happened to ChatGPT and, crucially, paste in the full text from the error message so it can see what's going wrong. After a bit of to-and-froing, it gives me a new batch of updated setup.py code which works, I rebuild the app as per instructions, and I finally have an app that loads!

I've updated **setup.py** to explicitly include **Tkinter** and bundle the **Tcl/Tk frameworks**, which should prevent that abort/crash:

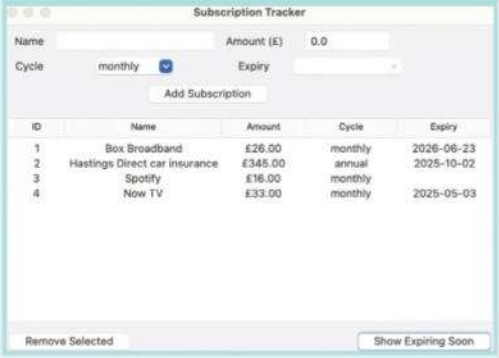
```
python
from setuptools import setup

# Use py2app to bundle the app along with Tcl/Tk frameworks
APP = ['subscription_tracker.py']
DATA_FILES = []
OPTIONS = {
    'argv_emulation': True,
    'packages': ['tkcalendar'],
    'includes': ['tkinter', 'tkcalendar'],
    # Ensure Tcl/Tk frameworks are bundled; adjust paths if your installation differs
    'frameworks': [
        '/Library/Frameworks/Tcl.framework',
        '/Library/Frameworks/Tk.framework',
    ],
    'plist': {
        'CFBundleName': 'SubscriptionTracker',
    },
}

setup(
    app=APP,
    name='SubscriptionTracker',
    data_files=DATA_FILES,
    options={'py2app': OPTIONS},
    setup_requires=['py2app'],
)
```

STEP 4 TEST THE APP

Now we've got a working app, I can start kicking the tyres, entering data to see if I can spot anything that's not working properly. It's worth testing out all the functions at this stage, and taking note of anything that's gone wonky. The AI's added buttons to remove selected subscriptions and show subscriptions that are expiring soon, so test those. See if you can break anything. Immediately I notice the date format is a rather unhelpful YY-MM-DD, so we'll add that to the top of the list of items to fix.



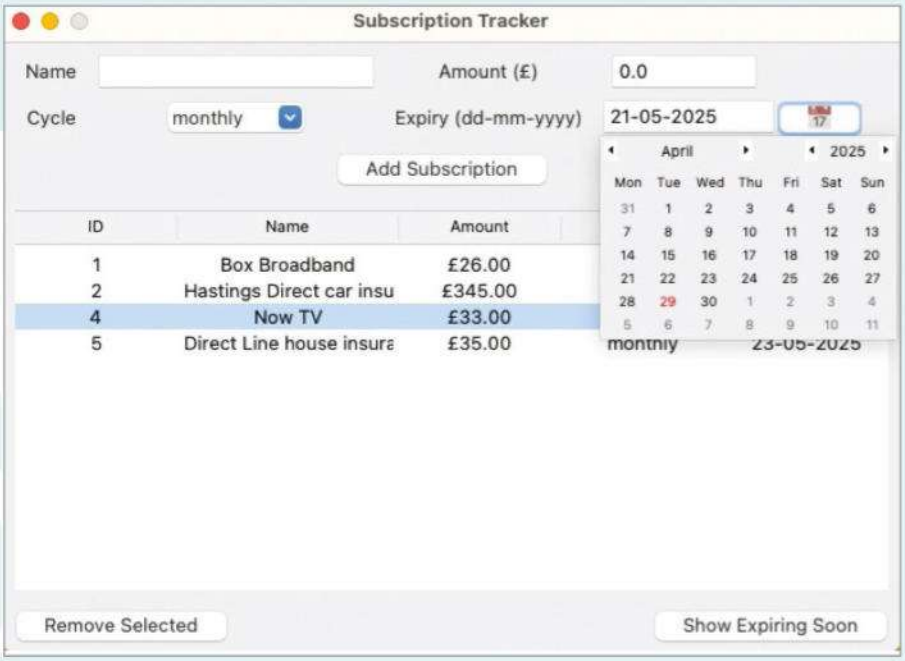
```
def add_subscription(self):
    name = self.name_var.get().strip()
    amt = self.amount_var.get()
    cycle = self.cycle_var.get()
    expiry_str = self.expiry_var.get().strip()
    expiry_iso = None
    if expiry_str:
        try:
            dt = datetime.strptime(expiry_str, '%d-%m-%Y').date()
            expiry_iso = dt.isoformat()
        except ValueError:
            messagebox.showerror('Error', 'Expiry must be dd-mm-yyyy')
            return
    if not name or amt <= 0:
        messagebox.showerror('Error', 'Please enter valid name and amount.')
        return
    self.run_query(
        'INSERT INTO subscriptions (name,amount,cycle,expiry_date) VALUES (?,?,?,?)',
        (name, amt, cycle, expiry_iso)
    )
    # Reset form
    self.name_var.set('')
    self.amount_var.set(0.0)
    self.expiry_var.set('')
    self.load_subscriptions()
```

STEP 5 FIX ERRORS ONE AT A TIME

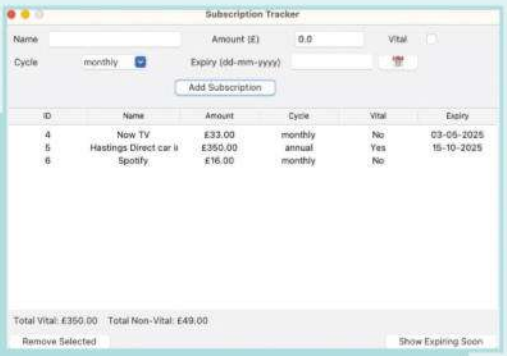
Even if you notice a handful of errors in your initial test, don't give ChatGPT a list of items to fix. Take one issue at a time. There are two reasons for this: first, the AI is easily confused if given a long list of tasks to complete; and more importantly, if you attempt to fix several bugs at once and something goes wrong with the code, you won't know which code fix introduced the error. So, I start by asking the AI: "How would I change the date format in the app from yy-mm-dd to dd-mm-yy?" I was rather hoping it would just give me the instructions on how to do it for ourselves, but it makes the code changes itself. However, it does comment where changes are made so you can see the relevant code.

STEP 6 TALK THROUGH REVISIONS

Another error I spotted in the initial test was erratic behaviour from the calendar drop-down menu that allowed you to pick an expiry date. It would only open on a double-click, and sometimes refused to open at all. Just like you would with a human coder, you have to patiently explain what's happening to the AI. For example, after one revision I tell it: "No, it's still broken. Clicking on the calendar first time is fine, and you can select a date. But if you try and change the date (because you've made a mistake), the calendar won't open again. And also you can't enter the date manually any more. The text field showing the date isn't editable." After four or five revisions, I finally get a working date-picker, but it takes patience. Be prepared to persist.



STEP 7 ADD FEATURES

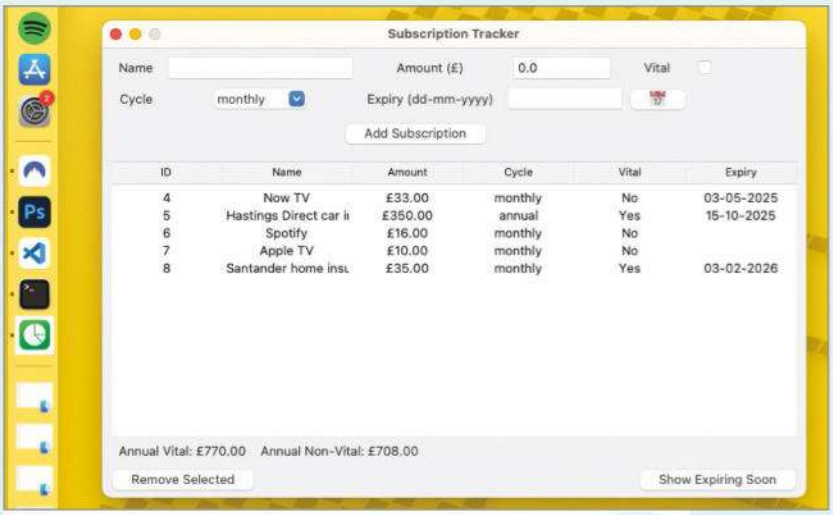


Once you've eliminated all the bugs, you can start to add features. For example, I want to flag some subscriptions/bill as "vital" to separate unavoidable bills such as house insurance from discretionary spend such as Spotify subscriptions. So I ask ChatGPT: "I'd like to add a feature where you can mark a subscription as 'vital', for subscriptions such as house insurance that you can't avoid. I'd then like to have totals for vital and non-vital subscriptions displayed. Can you do that?" It certainly can. It goes off to revise the code and delivers what I ask for. But...

STEP 8 CHECK EVERYTHING AGAIN

Every time you add a new feature, you need to check the app's functionality again. Make sure the change hasn't broken anything, not just the feature you've added. This is good practice for human coding, as well as AI. When I start adding subscriptions afresh, I notice the totals the AI is giving me don't discriminate between monthly and annual subs. So I need to ask the AI to sort that and make sure all totals are annual, or else the figures will be misleading.

Edited Setup
Answer in chat instead ?
I've adjusted the totals to be annualized:
Monthly subscriptions are multiplied by 12.
Annual subscriptions use their given amount.
SQL uses SUM(CASE WHEN cycle='monthly' THEN amount*12 ELSE amount END) for both vital and non-vital picks.
Rebuild in your ~/Desktop/"Temp Bin"/subtracker folder:
bash
cd ~/Desktop/"Temp Bin"/subtracker
rm -rf build dist
python3 setup.py py2app
./dist/SubscriptionTracker.app/Contents/MacOS/SubscriptionTracker
Let me know if it matches what you need!



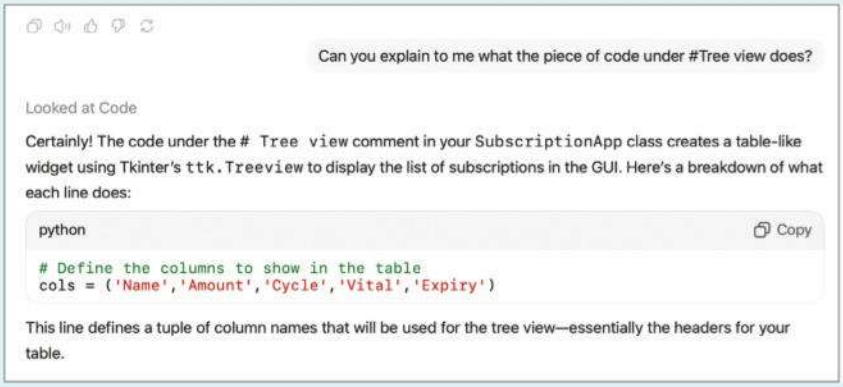
STEP 9 ASK AI FOR SUGGESTIONS

You don't have to do all the heavy lifting yourself in the (ahem) creative department. I ask ChatGPT: "Without altering the code at this stage, is there anything I could do to make the app more attractive/modern-looking?" It comes back with a range of suggestions, including giving the app its own icon, rather than relying on the generic Python icon. Nice idea. I even get ChatGPT to design an icon for me. It boldly offers to turn the finished icon into an .icns file that macOS would recognise, but doesn't know its own limits and screws the job up. Luckily, there are online apps that can do it for me, and now our app has its own icon, the green pie-chart one you can see here on the left. It annoyingly doesn't have the rounded corners of other Mac apps, but I can sort that.

I'm still seeing ID listed
Looked at Code
self.tree.delete(item)
# Fetch all
rows = self.run_query('SELECT id,name,amount,cycle,vital,expiry_date FROM subscriptions')
for id_, name, amt, cycle, vital, expiry in rows:
rows = self.run_query('SELECT name,amount,cycle,vital,expiry_date FROM subscriptions')
for name, amt, cycle, vital, expiry in rows:
disp_date = ''
if expiry:
app.mainloop()
The app now fetches only the relevant columns (excluding id), so the ID column should no longer appear in the table. Let me know if it's still showing or if you'd like to store the ID internally without displaying it.

STEP 10 EDIT WITH THE CHATGPT APP

If you don't want to go through the rigmarole of cutting and pasting code from ChatGPT in the browser to your coding environment (such as VS Code), you might not have to. The ChatGPT app (for Mac or Windows) can now interact with certain apps, including VS Code. To do this, open VS Code with your code open and then start a chat in the ChatGPT app and click the icon that looks like a small arrow in a square. You may be asked to grant permissions to allow VS Code to interact with ChatGPT. It should then be able to read your code directly from the app. If you ask it to make a code edit, as we've done here, it will first show you the planned changes in the ChatGPT app, then let you press a button at the top of the code pane to submit the changes. You should then see the amendments highlighted in VS Code itself.

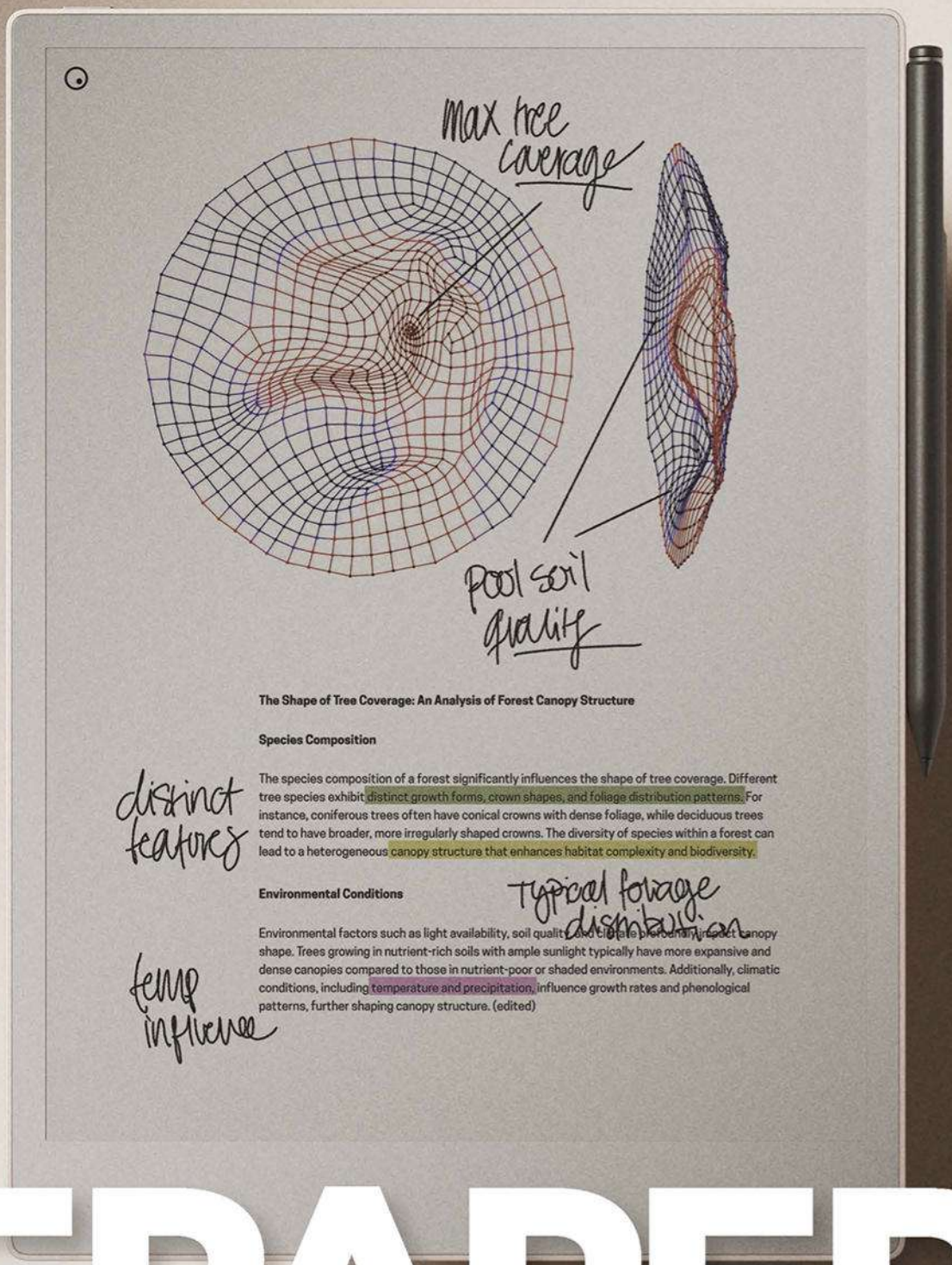

Can you explain to me what the piece of code under #Tree view does?
Looked at Code
Certainly! The code under the # Tree view comment in your SubscriptionApp class creates a table-like widget using Tkinter's ttk.Treeview to display the list of subscriptions in the GUI. Here's a breakdown of what each line does:
python
Copy
# Define the columns to show in the table
cols = ('Name','Amount','Cycle','Vital','Expiry')
This line defines a tuple of column names that will be used for the tree view—essentially the headers for your table.

STEP 11 HAVE CODE EXPLAINED

If you're even halfway curious, or you're trying to learn Python (or another language), you might want help understanding what a section of code does. This is another good use of the ChatGPT app, as you can have VS Code open in one window, ChatGPT in another, and ask questions such as: "Can you explain to me what the piece of code under #Tree view does?" Here, ChatGPT patiently goes through the code line by line, so you can better understand what each line does. If the explanations are too dense or you don't understand something, ask ChatGPT to break it down into more simple language.

STEP 12 FINISHING TOUCHES

You can keep iterating and refining the app with ChatGPT until you're happy with the finished product. Until now, I've been accessing the app from a folder on the desktop, rebuilding it after I committed each code change. But now I've finished developing, how do I add it to our Mac's Applications so that I can open it from Launchpad or Spotlight, for example? I ask ChatGPT and it gives me simple instructions on how to copy it over to the Applications folder and we're done. The app is now ready to use in Launchpad (bottom right). And, yes, I still need to round those corners off on the app icon...


Max tree coverage
Pool soil quality
The Shape of Tree Coverage: An Analysis of Forest Canopy Structure
Species Composition
distinct features
The species composition of a forest significantly influences the shape of tree coverage. Different tree species exhibit distinct growth forms, crown shapes, and foliage distribution patterns. For instance, coniferous trees often have conical crowns with dense foliage, while deciduous trees tend to have broader, more irregularly shaped crowns. The diversity of species within a forest can lead to a heterogeneous canopy structure that enhances habitat complexity and biodiversity.
Environmental Conditions
Typical forage distribution
Environmental factors such as light availability, soil quality, and climate profoundly impact canopy shape. Trees growing in nutrient-rich soils with ample sunlight typically have more expansive and dense canopies compared to those in nutrient-poor or shaded environments. Additionally, climatic conditions, including temperature and precipitation, influence growth rates and phenological patterns, further shaping canopy structure. (edited)
temp influence

EPAPER Everywhere

Low-power screens are appearing in all manner of devices. Barry Collins plots the rise of ePaper

Unlike its fibrous counterpart, ePaper is a slow burner. Although Amazon's Kindle and other ebook devices have been with us for almost 20 years, the ePaper technology has largely been confined to such readers – at least until the past couple of years.

Suddenly, ePaper is everywhere. In smartphones, tablets, laptops, monitors, smartwatches and other displays. And now that colour ePaper has entered mainstream production, it's likely we're going to see the technology further spread its wings.

There are many advantages that ePaper (often incorrectly referred to as E Ink, which is an ePaper brand) has over conventional LCD displays. It's low power, much easier to read in sunlight and relatively inexpensive. It has its drawbacks, too, of course. Snail-like refresh rates, ghosting and a lack of vibrancy when it comes to colour mean that it's only suitable for particular applications. Nobody in their right mind is watching YouTube videos on an ePaper tablet, for example.

Here, we're going to discover the different device categories that ePaper has wormed its way into and explore how it's changed the way people use such devices.

SMARTPHONES

Given that doomscrolling has reached a new peak in 2025, you can see why people might be tempted by a smartphone that's not brilliantly responsive, that isn't ideal for watching TikToks or YouTube videos.

ABOVE The Minimal phone is designed to keep distractions to an absolute minimum

At the truly Spartan end of the scale you've got devices such as the **Minimal phone** – a device that sets out to be "distraction-free". It has a 4.3in 3:4 ePaper display with a 230ppi resolution (the standard Kindle offers 300ppi, for reference). It also has a BlackBerry-like QWERTY keyboard at the bottom, to reinforce its retroness.

There are no icons or notifications to prod on the homescreen, just a stark list of functions, such as Book, Calendar, Music and Phone. It's not entirely divorced from 21st century communications, though, with Email and Messages among the options, as well a link to hail an Uber. And it has access to the Play Store, so you can install anything you can't live without.

Mod-cons aren't ignored, either. A 16MP camera sits on the rear, a 5MP selfie camera is somewhat awkwardly placed in the bottom left on the keyboard, a fingerprint sensor can unlock the beast and there's a 3.5mm headphone jack if you don't want to rely on Bluetooth. Claimed four-day battery life is another call back to the BlackBerry era, as is the price: $399 with free worldwide shipping from **minimalcompany.com**.

If it's more the ePaper display than the lack of distractions that appeals, the **BigMe Hibreak Pro** is more like a conventional Android smartphone. It has a 6.13in 300ppi display, and the 4,500mAh battery is right up there with capacities found on similar-sized smartphones with battery-sapping LCD displays.

The MediaTek Dimensity 1080 2.6GHz processor is a couple of years old now, but the screen places fewer demands on the hardware. The panel has a refresh rate of 21fps, which would be pretty painful for watching *Adolescence*, but should make scrolling through web pages less treacle-like than you might have experienced with the Kindle browser. The company claims that "auto ghosting removal" keeps the display clean, too.

It has a 5G dual-SIM, with a 20-megapixel rear camera that has been optimised for document scanning, and a 5-megapixel selfie camera, too. It costs £331 from **store.bigme.vip**, but was out of stock when we visited. Don't be tempted by the slower, earlier non-Pro models, which are long in the tooth now.

ABOVE The TCL 50 Pro NxtPaper can switch between mono and colour

Honourable mentions in this category should also go to TCL and Onyx. TCL's NxtPaper displays are actually LCD with – on its **TCL 50 Pro NxtPaper 5G** smartphone – a 1,080 x 2,460 resolution and a 120Hz refresh rate. However, the screens slip into a very convincing, monochrome paper-like mode that is certainly easier on the eye for reading, but doesn't enjoy the power savings of an ePaper display. The company offers NxtPaper tablets, too.

The **Onyx Boox Palma**, meanwhile, looks like a smartphone, but doesn't have phone/mobile data capability. Which brings us neatly to...

E-READERS/ TABLETS

The Onyx Boox Palma was arguably the sleeper hit of 2024. The smartphone-sized e-reader won plaudits all over the place, and was quickly followed up by the **Onyx Boox Palma 2**, which was physically identical to its predecessor but came with faster internals and an Android update.

It's a 6in device with a 2:1 aspect ratio, making it very much an e-reader that slips into a jeans pocket. It's based on Android 13, with full access to the Play Store, meaning you can download the Kindle app or that of any other e-book store. It's also ideal for reading those long web articles that give you screen fatigue on a phone/tablet. It's not a device you'll need to charge every night either – more like once a fortnight with modest use of an hour's reading per day. At £279 from **amazon.co.uk** it's more expensive than a Kindle – but it's much more versatile, too.

BELOW The Onyx Boox Palma 2 is a 6in e-reader that fits in your pocket

Colour screens are the big trend in e-readers at present. The **Amazon Kindle Colorsoft** released late last year impressed our reviewer, finally making it less painful to read graphic novels or comics on a Kindle. Panning and zooming is much better than you might expect, too, with no ghosting or artefacts as you scroll across a page. However, you do lose sharpness with colour: 150ppi compared to the 300ppi you get with monochrome text. And don't expect a glossy finish, either; it's a more muted look.

Amazon's certainly not the only one with colour screens, mind, and others go bigger than the Colorsoft's 7in display. The **Boox Note Air4 C** ups the display size to 10.3in, making it more of a tablet than an e-reader. It includes a stylus, too. It's about £300 more expensive than the Kindle Colorsoft, at €598 from **euroshop.boox.com**.

When it comes to scribbling on an ePaper display, reMarkable has carved out a strong reputation. Late last year it launched the **reMarkable Paper Pro**, its first colour device. As our reviewer noted, don't confuse this for an iPad-like tablet. It's dedicated to one job, which is scribbling notes as if you're writing on real paper (it's slightly smaller than a sheet of A4). There's no perceptible lag between the pen and the ePaper. Writing feels like writing, with the added convenience of digital storage.

There's an optional Type Folio keyboard case, but you're looking at around £739 (from **remarkable.com**) if you want the keyboard, or £559 if you can live without it.

ABOVE **The Kindle Colorsoft makes reading graphic novels a pleasure**

RIGHT **Dasung's Paperlike 103 has a useful touchscreen**

BELOW **The Lenovo ThinkBook Plus Gen 4: wide of the mark**

LAPTOPS

If anyone was going to try to make ePaper screens work on a laptop, it was Lenovo. That company has more laptop form factors than Boris Johnson has children, but it's beginning to look like an idea that hasn't landed.

In mid-2023, the company launched the **Lenovo ThinkBook Plus Twist**, which had a 13.3in OLED screen on one side of the lid and a 12in colour E Ink touchscreen on the other. It tried again in 2024 with the **Lenovo ThinkBook Plus Gen 4**, which had pretty much the same display configuration. Neither blew away our reviewers. A choppy refresh rate and ghosting on the screen marred the experience, making the ePaper screen far less satisfying than an iPad for taking notes or reading. Not to mention the fact that it cost the thick end of £3,000 and was a lot thicker than a tablet.

Lenovo appears to have shelved the concept. The ThinkBook Plus Gen 4 is no longer on sale in the UK, and there don't appear to be any other ePaper alternatives in its extensive range. No other laptop manufacturer appears to have picked up the mantle either, suggesting this might have been a form factor too far for ePaper.

However, there is a possibility that ePaper will rise again on laptops, albeit in a more decorative sense. At CES 2024, Lenovo showed off concept laptops with ePaper lids that could be used to display different images or patterns, allowing users to personalise their laptops without smothering them in stickers. Asus showed off something similar at last year's Computex. We've yet to see the concept arrive in a production model, though.

MONITORS

If building an ePaper screen into a laptop is an idea that didn't fly, there might be a market for portable displays that use the technology. Earlier this year, Chinese firm Dasung launched the **Paperlike 103**, which it claimed was the first ePaper display with a 60Hz refresh rate. That's not exactly rapid by today's monitor standards, but it's fast for an ePaper display.

The 10.3in panel has a 1,872 x 1,404 resolution, and it's a capacitive touchscreen, meaning that you could perhaps use it as a secondary display for scrolling through social media feeds or for reading through documents. It's got physical buttons on the front bezel too, for changing the light colour, contrast and other settings.

It isn't cheap. New models are selling on eBay for in excess of £400, and there's a big, splashy warning on the company's website fending off Apple customers. Connecting Macs, iPhones or iPads could cause screen jitter or display-instability issues, apparently.

There are full desktop monitors with ePaper screens, too. Dasung sells models itself, as does Boox Palma maker, Onyx. The **Onyx Boox Mira Pro** is a 25.3in display with a 3,200 x 1,800 resolution (145ppi) that's compatible with Windows, Mac, iOS and Android, although it's worth nothing that Onyx suggests choosing a resolution of 1,400 x 1,050 when connected to Windows devices and 1,600 x 1,200 on Macs, so you're not going to get anywhere near that full resolution in practice.

There's no official refresh rate stated, but it does have a video mode that boosts the refresh speed for YouTube videos. We've not seen a

ABOVE **Philips' 24B1D5600 is a 23.8in LCD with a 13.3in E Ink panel on the side**

model ourselves, but most reviews suggest it's better for reading than watching multimedia, as you might expect. The screen can flip into portrait mode for reading documents, and there are speakers built in, too. The newly launched colour version supports 4,096 colours and costs $1,899 ($1,425) from **shop.boox.com**.

Perhaps the most intriguing ePaper monitor is the sexily titled **Philips 24B1D5600**. It consists of two parts: a 23.8in LCD with a 13.3in portrait E Ink panel on the side, making a super-wide monitor. The E Ink part of the display can be tilted inwards by 45 degrees to prevent you having to swing your neck from side to side, like you're watching a match on Centre Court.

The ePaper segment is intended for reading and reviewing documentation while you do the bulk of your work on the QHD IPS screen alongside it. Alas, it seems Philips is yet to sell this outside of the Asian market, where it was launched in 2023 for around $600. You might be able to pick one up on import, however.

SMARTWATCHES

Smartwatches have followed the same battery-life trajectory as smartphones. Early but limited pioneers such as Pebble measured battery life in days, whereas most contemporary LCD smartwatches can barely get through a day before needing a suck on the mains.

However, Pebble's on the way back, albeit with a different name. The bones of the original Pebble were sold to Fitbit back in 2016, but founder Eric Migicovsky is launching a pair of new devices with the trademark ePaper screens. The **Core 2 Duo** (that noise you can hear is Intel's lawyers rubbing their hands together) has a 1.2in monochrome ePaper screen, and will cost only $149 when it launches in July from **store.repebble.com**.

The $225 **Core Time 2** has a colour 1.5in screen, and throws a heart-rate monitor into the mix along with the barometer and compass you get with the Core 2 Duo. The revamped PebbleOS isn't going to match Apple Watch levels of sophistication, but they both offer up to 30 days of battery life, which is the kind of duration Apple Watch owners can only get if they turn the watch off and Tippex the time on to the screen.

Pebble and its phoenix firm aren't the only ones to have dabbled with ePaper screens on smartwatches. **Fossil's Hybrid HR Series** featured 1in E Ink displays beneath mechanical hands, while Sony briefly dabbled with an ePaper display for its **FES Watch U** back in 2018. That even carried the ePaper along the strap, allowing the strap to bear the same design as the watch face. It didn't catch on, though.

LEFT **The $149 Core 2 Duo has a 1.2in monochrome ePaper screen**

ART AND SIGNAGE

E-paper is perfect for products such as wall art and signage because it only needs power when you change the image. However, until recently the quality of larger ePaper displays wasn't something you'd want to hang on your living room walls.

Pocketbook's InkPoster has changed that. We spotted this product at CES in January, with ePaper wall art that was genuinely difficult to tell apart from conventional prints. It will launch in three sizes: 13.3in (1,200 x 1,600), 28.5in (2,160 x 3,060) and 31.5in (2,560 x 1,440).

The company isn't just offering eye-catching hardware, but an art collection to go with it, with an accompanying app that offers a pick of "thousands of iconic masterpieces" that have been "handpicked by expert art consultants". Just tap what you want on your walls, and it's redrawn within minutes. The frame itself needs charging about once a year.

ABOVE **The InkPoster is hard to tell apart from traditional prints**

The smallest frame starts at $600, the biggest costs $2,400, and we rather suspect there will be a subscription fee for the art, too. It's due out this year from **inkposter.com**.

Sharp NEC makes its own ePaper displays, and it's coming after the signage business in hotels and other venues, as we first revealed in Briefing in issue 360. Its ePaper displays come in two sizes – 25.3in and 13.3in – and are intended for information that changes occasionally, rather than frequently, such as menus in restaurants or conference room signage. The **Sharp/NEC ePaper Displays** start from £880 exc VAT.

MICROSOFT DESIGNER

Nik Rawlinson tries out a free, AI-powered tool that can quickly put together social media images and more

Microsoft Designer is a quick, simple and free way to create high-quality images and designs that are ideal for sharing online. Since it's underpinned by OpenAI's DALL-E image engine, it can generate custom visuals representing anything you care to type in. However, it's more than just an image generator – you can upload and edit your own photos too, and optionally combine them with AI-generated elements, to produce original, eye-catching content.

How do I access it?

Designer can run entirely in a web browser – just hop over to **designer.microsoft.com** to try it out – so you can use it on almost any platform, including macOS and Linux. If you prefer a native app, however, you can download a Windows-based front-end to Designer from the Microsoft Store, or install mobile apps for Android and iOS via their respective app stores.

However you access Designer, to get started you merely need to log in with your regular Microsoft account. Your work will be automatically saved to OneDrive (so note that it will count against your storage quota); click My Projects at the top of the Designer homepage to revisit previously created projects.

What does it cost?

You can make full use of Microsoft Designer without paying a penny. The only limitation is that regular free users only get 15 AI credits per month, meaning you can only use Designer's AI image generation or editing features 15 times before they run out. After that you'll have to wait until they're replenished at the start of each calendar month.

Subscribers to Microsoft 365 Personal or Family get a bigger allowance of 60 AI credits. However, these aren't just for Designer; they're shared across all Office apps, so you'll also use a credit when, for example, you use Copilot to update a spreadsheet in Excel. Hardcore AI fans can sign up for a Copilot Pro subscription, which costs £19 per month for unlimited credits.

Aside from credits, there are currently no extra features in Designer for Microsoft 365 subscribers, but this could change in the future. A note on the web page states that Designer "will be available both as a free app and with more premium features available to Microsoft 365 Personal and Family subscribers. Some templates may also require a subscription."

Whether you're using it for free or subscribing, be aware that Designer is only licensed for personal, non-commercial use. You probably won't get into trouble if you use it to make a poster for your shop, but if you want to create visuals for a major marketing campaign, you might need to pick a different tool.

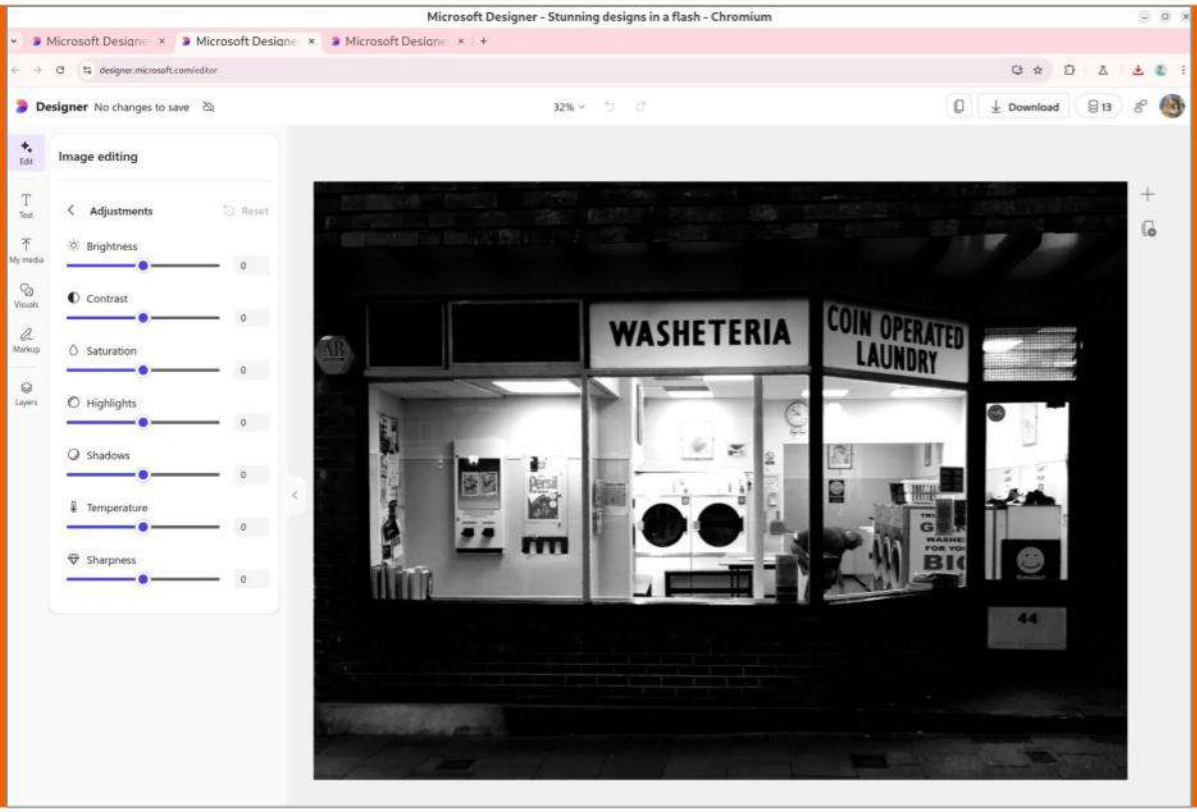
1 Edit your own images

Although Designer is proudly about AI, it also makes an easy photo-editing and enhancement tool. You can upload as many images as you like to Designer – the only limit is the capacity of your own OneDrive account. Your files won't be made public unless you intentionally choose to share them, but once they're in OneDrive they'll continue to consume space until you clear them out; deleting a project in Designer doesn't remove your uploaded assets, so this needs to be done manually via the File Explorer or the OneDrive website.

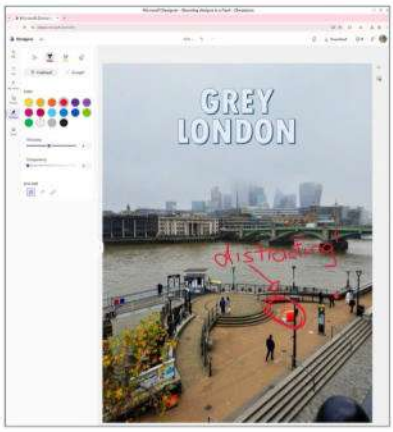
To upload and edit a photo, click the "+ Create" button at the top of the Designer window, then select "Edit image". In the new window that opens, click "This device", "Phone" or "My media" to select your image source – or just drag and drop files from a local drive into the window itself. Once your picture is uploaded, you can use a range of tools to remove, blur or colour the background, or to apply focus and colour effects.

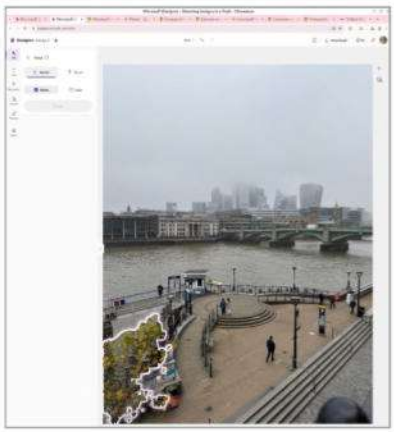
There's also a selection of filters on hand to adjust the colouring, and in "Quick actions" you'll find tools to crop, rotate or automatically enhance your image, plus manual adjustments for tweaking the brightness, tone, colour balance and sharpness.

In the main left-hand toolbar you'll see options to overlay text on your image, or to bring up Designer's markup tools. These let you draw



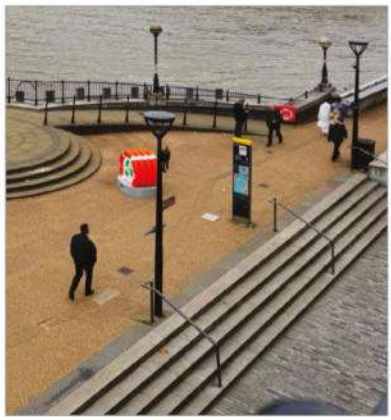
LEFT Designer lets you apply granular tweaks to your photos

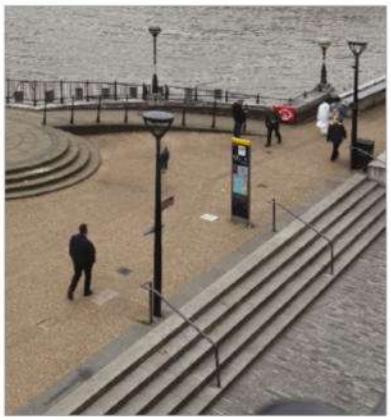




FAR LEFT You can annotate images using Designer's built-in tools

LEFT Hovering over an element in a picture highlights it for removal





LEFT One click and the bright orange object has disappeared

ALTHOUGH DESIGNER IS PROUDLY ABOUT AI, IT ALSO MAKES AN EASY PHOTO-EDITING AND ENHANCEMENT TOOL

freehand squiggles (or straight lines) on top of an image in various colours, and highlight areas by colouring over them. In the screenshot on the left we've used the pen tool to pick out a distraction in this otherwise muted shot of London – perhaps to ask a professional image editor to adjust it.

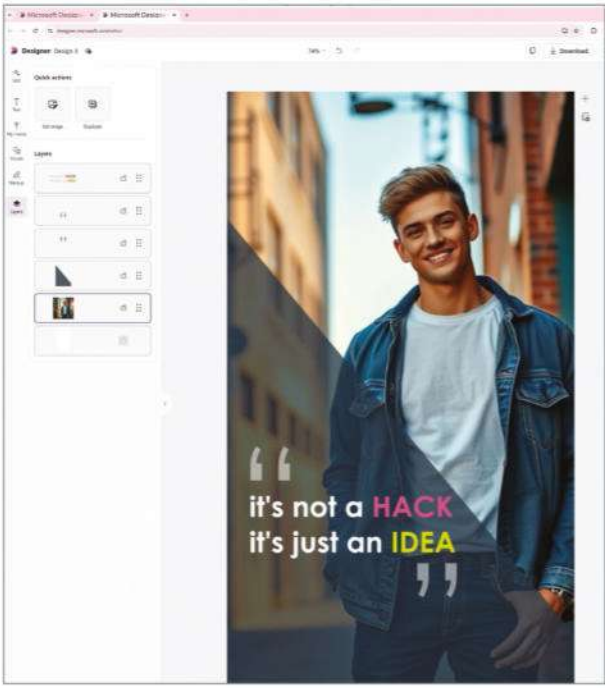
Once you've enhanced and marked up your image, you can download the edited version by clicking Download at the top of the screen and selecting a format (JPEG, PNG or PDF).

2 Erase unwanted objects

In the previous step, we used Designer to mark up an unwanted image element. However, if you want to completely remove something from an uploaded shot, you can do it directly within Designer.

Start by ensuring Edit is selected at the top of the far-left sidebar, then click Erase in the "Object transform" area of the second sidebar. On the following screen, hover your mouse over the object you want to remove; as you move it across the picture, you'll see that the elements it passes over are highlighted. In the screenshot on the left we've hovered over the tree so you can see the effect more clearly.

Click on the item you want to remove and it will be outlined; now click Erase and Designer will analyse the object and its surroundings, delete it and generate new content to fill in the gap. It made a good clean job of this with our test photo, as you can see



from the before and after comparison. Microsoft says that it intends to add generative expand capabilities to Designer too, making it possible to extend photos beyond their original bounds, although there's no word on how soon this might arrive.

Note that removing an object from the scene is an AI feature, which means it uses one of your AI credits. You can see your remaining balance in the lozenge at the top right of the interface window, just next to your user icon.

3 Generate your own AI images

One of the headline capabilities of Designer is generating new images from written descriptions. To try this out, return to the Designer homepage, click "+ Create" on the top bar and select "Images" from the menu. Now type a description of your desired scene into the Description box, and select a shape from the Size box.

To help you get what you want, each generation produces up to four variants; even so, we recommend you make your prompt as precise and detailed as you can. Since each generation deducts one credit from your AI balance, you don't want to waste credits by having to rephrase and refine your image multiple times.

Having said that, we've found the image generator works best with broad vibes rather than specific details. We tested Designer with a lengthy prompt, asking it to create a photorealistic image of a race in a pretty European city, showing the winner crossing the finish line, the crowds, a clock showing the winner's time and branding for the event's sponsor, *PC Pro*.

You can see above an example of what it served up. The image isn't bad, but the *PC Pro* branding is nowhere to be seen, and the clock showing the runner's time is nonsensical. It's also weird that in one of the images the athlete is running in the opposite direction to everyone else.

4 Create for social media

If you're running a social media account, you'll want to be creating content that's the right size and shape for your target platform. Microsoft Designer gives you a head start here, offering a range of templates in perfect sizes for Instagram stories, Facebook ads, LinkedIn posts and so on.

To find these templates, click "+ Create", then scroll to the bottom of the list of content types to find the social media post options, then select one to open a blank canvas of the appropriate proportions. In the screenshot above we've chosen to create an Instagram post, importing an AI-generated image from elsewhere and overlaying our own text on top of it.

The image and text sit on different layers; when we first imported the AI-generated man he appeared on top of the stack and obscured our message, but we were able to easily send him to the bottom by clicking Layers in the far left sidebar, grabbing the handle to the right of his block, and dragging him down (note that you can't drag any layer to the very bottom, as that would position it beneath the background).

You can also use Designer to produce larger images, with options for A5 and A4 portrait-orientation documents. These give plenty of space for text, so they're ideal for flyers, posters and informational signage. Designer isn't really intended for print production, though, so it doesn't offer any larger sizes than this, nor any options for high-DPI or CMYK output.

ABOVE LEFT **The AI-generated images may still have some quirks**

ABOVE RIGHT **Microsoft Designer provides templates for different social media formats**

5 Share your work

Once you're happy with your design, you'll probably want to share it. The easiest way is to click the "Copy as image" button at the top of the interface, then simply paste it into whichever application or website you want to use. Alternatively, you can click Download and choose a format, or hit "Send to phone" to generate a

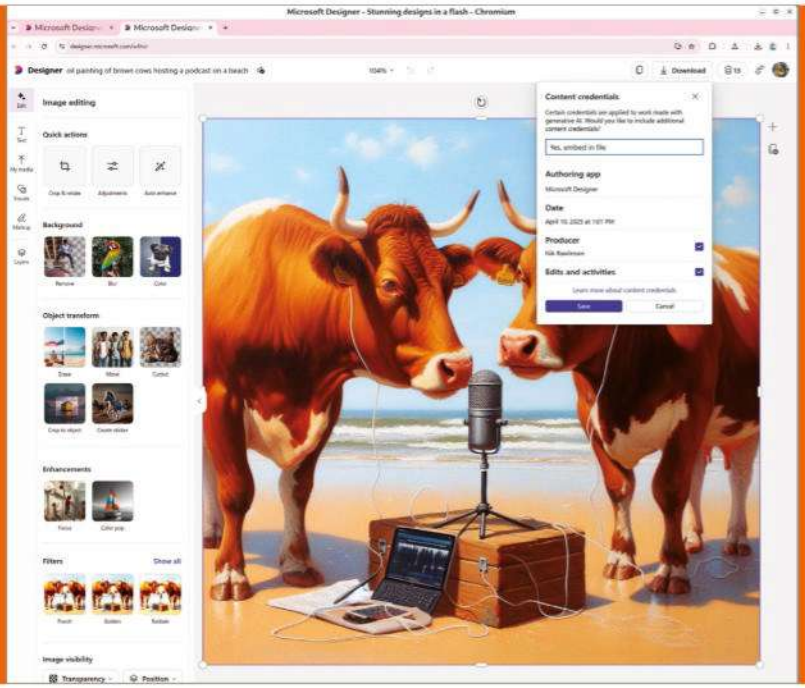
AI, OR NOT AI? NO NEED TO QUESTION

AI-powered image generation is a controversial subject, and Microsoft is a major promoter of content credentials that reveal when the technology has been used, along with organisations including Adobe and the BBC.

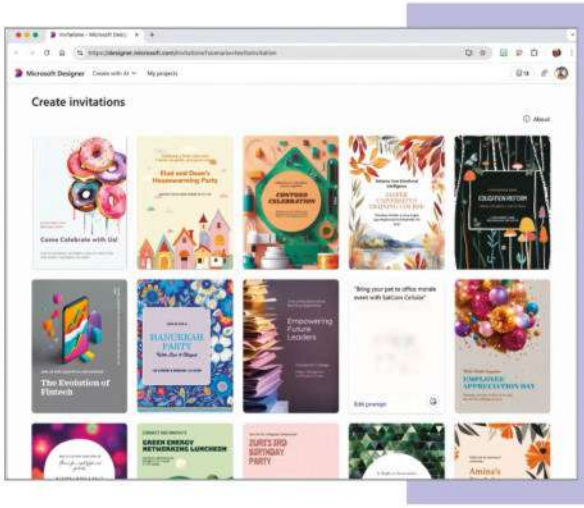
It's also a co-founder of Project Origin, a website where you can upload images to view their metadata and check whether the use of AI has been disclosed. If you want to examine a suspect image for yourself, simply upload it to originverify.iptc.org.

We didn't always find the overview results entirely clear, because not everyone uses the same standards for flagging AI images. However, if you expand the default view to show the full metadata – by clicking "See more metadata" at the bottom of the sidebar – you can often find notes such as "AI Generated Image" appearing in various data fields.

ONE OF THE HEADLINE CAPABILITIES IS GENERATING NEW IMAGES FROM WRITTEN DESCRIPTIONS



RIGHT You can attach additional credentials to your image



SAVE YOUR AI CREDITS WITH FREE TEMPLATES

Although Designer only allows you a limited number of free AI operations per month, it also includes a decent library of pre-rolled AI designs, which you can customise and use without spending a credit. To browse them, hit the "+ Create" button, scroll down to the "Create with AI" section of the drop-down menu and chose from a range of image types; options include banners, framed images, invitations and more.

You'll now see a page showcasing a dozen or more AI-generated templates of your chosen type. When you see one you like, hover over it and hit the "Edit" icon in the lower right-hand corner to freely adjust the non-AI elements, such as replacing the default text with your own, or swapping out a stock photo for one you've uploaded.

If the template doesn't quite hit the spot, you can also examine and tweak the instructions that generated it, by hovering over it and selecting "Edit prompt". This lets you not only view and refine the original AI prompt, but also change the style – options include photorealistic, watercolour, pop art and more – and define a tasteful colour palette. Needless to say, though, if you re-render the image with new parameters, that will cost a credit.

IPTC Origin Verify - Verify the source of your news - Chromium
IPTC Origin Verify
Origin Verify
News Provenance Verification
Reset
See less metadata

QR code that will download your image directly onto a mobile device.

If you've used AI in producing your image, Designer will automatically add content credentials to the metadata of the exported file, declaring this fact to anyone who cares to examine it (*see "AI, or not AI?", opposite*). This applies not only if an image is entirely AI-generated, but also if you used AI to remove an image element, or – in the future – to extend a picture beyond its original bounds.

You can also embed additional metadata of your own if you want to be positively identified as the producer of an image. To do so, click "Manage content credentials" at the bottom of the Download menu, then, on the following page, click to change "No, don't include" to "Yes, embed in file". You can now choose to have your name tagged in the file, alongside details of the edits you've performed.

Next-gen connectio

As our devices get smarter and faster, we need new connectors to keep them all working smoothly together. **Darien Graham-Smith** examines the ports and technologies you might see on your next computer – or the one after that

Next-gen USB/Thunderbolt

You can't talk about the future of USB without talking about Thunderbolt, and vice versa. Although these two general-purpose interconnects were originally completely separate, with different plugs and cables, the latest Thunderbolt standards are supersets of USB, and operate over the same physical sockets.

What that means in practice is that while the USB-C ports on your laptop will definitely support USB peripherals, they might (or might not) also support Thunderbolt – as long as you're connecting a Thunderbolt-compatible device with a Thunderbolt-compatible cable. This somewhat confusing situation won't going to change in the foreseeable future, because right now no future versions of USB or Thunderbolt have been announced. That doesn't mean we won't see any movement, though: few devices are up to date with the latest standards, so the evolution in the next few years will be all about widespread adoption.

On the USB front, the name of the game is USB4. (Note that that's not USB 4 or USB 4.0, but USB4 with no space – the USB-IF just can't help fiddling with the branding.) USB4 was actually launched, with zero fanfare, in 2019; you might even already be using it without realising it, as it's built into most recent Apple computers, along with a number of high-end AMD and Intel motherboards.

USB4 uses the same USB-C connectors and cables as previous USB 3 devices, and supports all the same transfer modes, up to 20Gbits/sec. In addition, it enables a new 40Gbits/sec mode for compatible devices, along with the ability to "tunnel" PCIe connections over a USB link – providing a simpler way to attach external devices such as NVMe SSDs.

In 2022, USB4 v2.0 brought even bigger bandwidth benefits: USB4 v2.0 devices can take advantage of an ultra-high-speed 80Gbits/sec connection mode, or a new asymmetric mode supporting 120Gbits/sec upstream and 40Gbits/sec down – ideal for driving multiple high-resolution monitors over one cable.

Meanwhile, Apple has recently started to roll out its first machines equipped with Thunderbolt 5. Still running over a USB-C connection, this raises the available connection speeds to match those of USB4 v2.0. In fact, now that USB4 supports ultra-fast connections and PCIe tunnelling, there's very little advantage to using Thunderbolt, except in terms of device support: most of the fastest external SSDs on the market currently use Thunderbolt 5.

In our view, if the latest USB standard makes Thunderbolt superfluous, it's a good thing – particularly for AMD. While Thunderbolt co-creators Apple and Intel have been free to build the technology directly into their platforms, anyone wanting to build a Ryzen-powered laptop or PC with Thunderbolt support has had to pay extra for a licensed controller. That could be a non-issue in future.

Next-gen RAM

RAM keeps getting faster and faster. Where the original DDR standard (introduced in 1998) supported a maximum speed of 400MT/sec, current mainstream DDR5 modules can deliver up to 8GT/sec, or 64GB of data per second. Capacity has rocketed up, too, from a maximum of 1GB per module to a massive 512GB.

In the next year or two, expect to see the debut of DDR6. The standard hasn't yet been finally approved, but we know that it will officially raise the performance bar to 12.8GT/sec – and, as with previous generations of DDR, you can expect to see enthusiast hardware go well beyond the official specification, likely pushing bandwidth up to 16GT/sec.

As ever with memory, though, the raw numbers don't tell the whole story. Although the new memory interface supports higher speeds than ever, the actual cells on the memory chips won't necessarily be any faster than the ones currently used in DDR5 modules. It will probably take several years of manufacturing refinements before the performance potential of the technology can be fully realised. However, DDR6 also promises to boost speeds by increasing parallelism, using four memory channels per module rather than two – so there's a potential benefit to be gained even from first-generation DDR6 DIMMs.

While DDR6 is likely to use a similar slot design to DDR5, we're also seeing a new development in the physical connector used for laptop RAM. In the past decade we've become accustomed to soldered-in memory chips that can't be upgraded;

We're hopeful that CAMM2 will become the norm for mobile computers. That will mean your laptop can once again grow with your needs

ns

this helps manufacturers make laptops slimmer and lighter, but it's a bummer if you care at all about upgradability.

That could be fixed by a new standard called CAMM2 – short for Compression Attached Memory Module, version two (the first version was a never-released prototype). CAMM2 modules do exactly the same job as regular

DIMMs, but rather than using a traditional slot connector, CAMM modules lie flat on the motherboard, secured by screws. On the underside, a grid of contacts is held firmly against corresponding pins on the motherboard; the whole assembly is barely any bigger or heavier than a set of soldered chips, while crucially remaining replaceable.

So far we've only seen a handful of laptops that use CAMM2, but it's an official JEDEC standard, so we're hopeful it will become the norm for mobile computers. Not only will that mean your laptop can once again grow with your needs, it will also mean you can shop around for competitively priced memory modules, rather than being stuck with whatever the manufacturer chooses to charge. We're even seeing CAMM2 connectors appear on some desktop motherboards: because the modules lie flat, they don't obstruct access to internal slots and connectors in the way that DDR modules can.

Next-gen PCIe

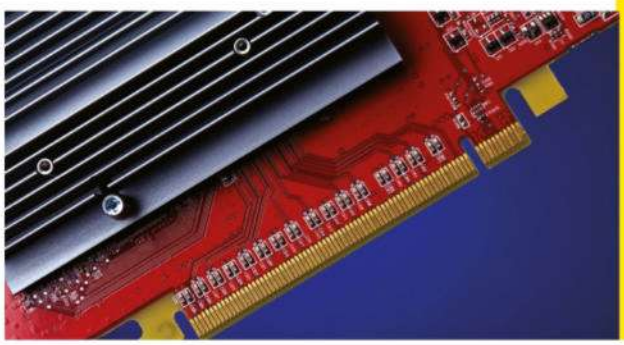
If you read our recent look at the PCIe interface (*see issue 367, p40*), you'll recall that the next-gen PCIe 6 standard has already been finalised, but with its enormous bandwidth of up to 121GB/sec it's excessive for most uses, and most mainstream platforms have so far stuck with PCIe 5.

However, the PCI-SIG continues to drive the technology forward. PCIe 7 is expected later this year, doubling the potential data throughput again to 242GB/sec. Don't expect to see it in the wild any time soon, though: this cutting-edge standard will require significant upgrades to manufacturing processes, which we doubt anyone's going to invest in until there's meaningful demand.

But let's not write off the potential of massive-bandwidth buses. While today's PCIe standards are ample for current SSDs and gaming cards, a faster connection could be useful for heavyweight data-processing models such as AI engines – assuming you have tens of thousands of dollars to spend on the number-crunching hardware to plug into the slot, and a sufficiently fast CPU and memory subsystem to pair it with.

At any rate, if you have an option of going for PCIe 6, there's no downside. PCIe is one of those wonderful standards that's both backward and forward compatible, so if you're drooling over a new PCIe 6 card but don't have a compatible motherboard, you can still plug it into your PCIe 5 slot; it just might not run quite as fast. And if you opt for a PCIe 6 motherboard, you'll still be able to use older PCIe cards.

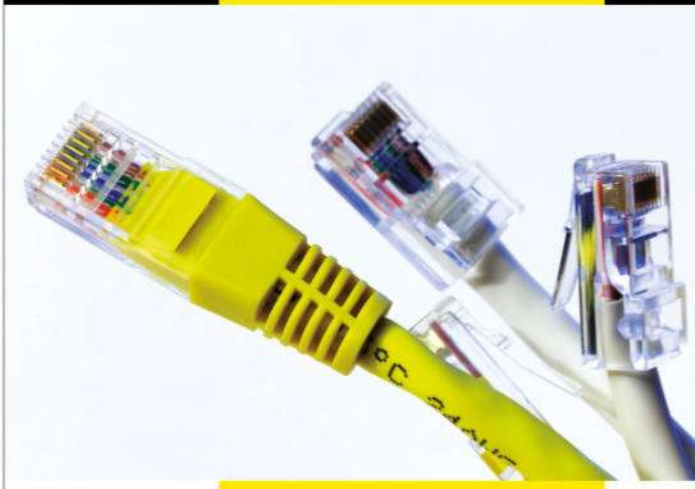
Incidentally, now USB4 supports PCIe connections over a USB-C cable, this broad compatibility also applies to outboard connections, to things such as external SSDs. However, performance will be limited by the speed of the USB connection: even the very latest 80Gbits/sec USB hardware won't be able to match the bandwidth of a PCIe 6 x16 slot.



PCIe is one of those wonderful standards that's both backward and forward compatible

Next-gen Ethernet

Ethernet isn't widely used in most people's homes, except perhaps for connecting an ISP modem to a router, or hooking up a personal NAS appliance. In business, things are different: data centres use miles and miles of ultra-fast network cabling to connect servers, gateways, security appliances, wireless access points and more.



If you want to upgrade your wired networking, therefore, the "next generation" of home Ethernet usually just means catching up with what enterprises were using a decade ago. In practice, while many large organisations are currently using 10GbE for everyday connectivity, home devices are just starting to move to the cheaper, simpler 2.5GbE standard.

While this clearly involves a performance compromise, it's a very practical choice for domestic roles, as it will work over almost any cable that's rated for gigabit connections, and is fully backward compatible with gigabit gear. There's little point going higher anyway, because few home devices are capable of transmitting or routing data at more than 2.5Gbits/sec (around 310MB/sec). Even the latest fibre broadband connections rarely come close to this speed.

If you do want something faster, you can buy a 5GbE USB or PCIe adaptor for under £40, which should still work with generic Cat 5e Ethernet cables. You can even step up to a 10GbE PCIe card for not much more, although we haven't seen any USB adapters that work with this standard – and it's recommended to use Cat 6A cabling for a reliable 10Gbits/sec connection.

Next-gen HDMI and DisplayPort

The latest version of the HDMI standard was announced in January at CES. Rejoicing in the memorable name "HDMI 2.2", the new audio and video interconnect doubles the maximum data rate from 48Gbits/sec to 96Gbits/sec – enough bandwidth to play back uncompressed 8K HDR video at 60 frames per second.

The updated standard formalises a feature called HDMI Fixed-Rate Link (previously introduced in HDMI 2.1b), which simplifies signalling and provides a more stable connection at the highest bit rates by always communicating at the maximum speed supported by the cable. On that note, you'll be delighted to hear that if you want to make use of the new increased bandwidth of HDMI 2.2, you'll need a new "Ultra96"-branded cable.

HDMI 2.2 introduces one other new feature that could greatly improve your media experience, but while this one doesn't need new cables, it does require device support. It's a technology called LIP, short for latency indication protocol, and it allows devices connected to an HDMI source to share information about their native latency. With this information, screens and sound systems should be able to automatically sync up perfectly, putting an end to irritating lip-sync problems and fiddly timing adjustments.

Alongside HDMI 2.2, CES also saw the unveiling of the new DisplayPort 2.1 standard. This enables connections at up to 80Gbits/sec over a distance of up to three metres – up from one metre in the previous standard – making it much more convenient to run multiple large displays from a single source. Inevitably, though, this will require – you guessed it – a new cable.

We don't need to wait for the next version of Wi-Fi for faster speeds – we just need to wait for device manufacturers to embrace what's already possible

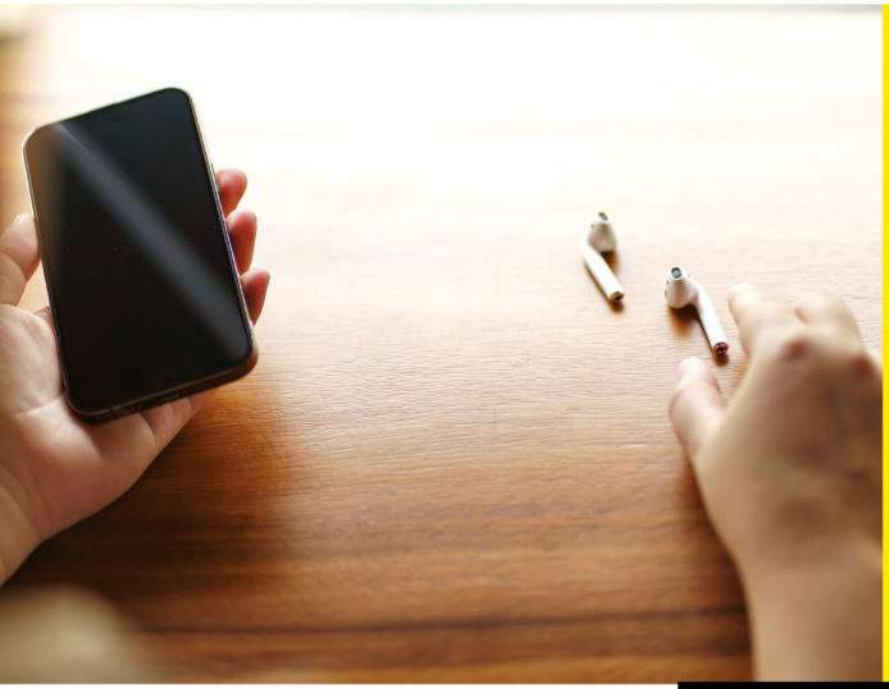
Next-gen Wi-Fi

Wi-Fi 7 is increasingly appearing on the latest routers, smartphones and laptops, but so far we've found its performance something of a letdown, rarely outpacing cheaper Wi-Fi 6 hardware. This has a lot to do with the flexibility of the Wi-Fi 7 standard, which allows devices to take advantage of the core protocols without necessarily having to implement performance-enhancing (and pricey) features such as high-speed radios, 6GHz band support or the new multi-link operation mode.

As such, we've yet to see anything that really takes full advantage of Wi-Fi 7's potential: even the fastest, most expensive Wi-Fi 7 router we've tested – the £700 Netgear Nighthawk RS700 (*see issue 353, p76*) – has a maximum connection speed of 11.5Gbits/sec on the 6GHz band, a mere quarter of what the standard allows for.

This means we don't need to wait for the next version of Wi-Fi for faster speeds – we just need to wait for device manufacturers to embrace what's already possible, with progressively faster systems hopefully trickling on to the market over the next couple of years.

After that, Wi-Fi 8 is on course to be finalised in 2028. Not much has yet been revealed about this update, but we know that it's officially called 802.11bn, that it will be branded "UHR" – short for "ultra-high reliability", an admirable goal – and that the intention is to raise the maximum connection speed to 100Gbits/sec.



6G isn't something you should expect to see in the next few years: right now the standard is more a set of design goals than anything actually buildable

Next-gen Bluetooth

The Bluetooth 6 standard was finalised last year, and we're expecting to see it appear in high-end smartphones in the latter half of 2025. Technical enhancements include faster device detection and better bandwidth sharing, so more Bluetooth devices can communicate with a single phone or laptop without causing stuttering and lag.

By far the most interesting new feature in Bluetooth 6, however, is something called channel sounding. Simply put, this allows connected devices to estimate how far apart they are, to an accuracy of around 10cm.

If this sounds familiar, it's because Apple's Find My Device tool has been offering precisely this capability for years, enabling an iPhone to very quickly home in on an AirTag or a misplaced Apple Watch. However, where Apple uses a proprietary ultra-wide-band transceiver for this, Bluetooth 6 will make these features freely available to all brands of headphones, smartwatches and other personal devices – so no matter what platform you're using, you can at last stop losing your gadgets.

By far the most interesting new feature in Bluetooth 6 is channel sounding. Simply put, this allows connected devices to estimate how far apart they are

Are you ready for 6G?

It's a bit of a standing joke that, six years after the rollout began, you still can't get a reliable 5G signal in half of the country. Nevertheless, work is already under way on the next-generation 6G standard. Unlike most of the other technologies we've talked about on these pages, though, 6G isn't something you should expect to see in the next few years: right now the standard is more a set of design goals than anything actually buildable, with the final specification not expected until around 2030.

Still, those goals are enough to give us a sense of what 6G will do for us. The main target is, as ever, increased bandwidth: it's been suggested that a theoretical peak of one terabyte per second could be attainable, though only in short bursts over short distances. More than this, 6G is intended to slash latency, via both more efficient communication streams and the widespread deployment of edge servers, meaning you should normally be only a few hops away – in network terms – from performance-critical resources.

In particular, 6G is supposed to be fast enough for real-time augmented reality applications, making it possible to swing your phone or headset around and see virtual elements, streamed from the cloud, overlaid onto your environment in real time.

At the other end of the spectrum, in areas where it's not possible to provide a strong signal with local edge services, it's also planned that 6G hardware will include built-in support for satellite services. That means every 6G phone will always be able to get some type of connection, no matter where it's located on the Earth – unless it's at the bottom of a coal mine, of course.

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Moto Razr 60 Ultra

A stunning screen, great cameras, superb battery life and a powerful chipset make this the best flip phone yet – but it comes at a price

ABOVE **The Razr 60 Ultra may just persuade you to move to a flip phone**

SCORE ★★★★½

PRICE £917 (£1,100 inc VAT) from motorola.com

Folding phones are no longer the hot new thing, but Motorola's Razr mobiles keep getting better. The Razr 60 Ultra is the best take we've seen on the flip format, although the cost pits it against formidable non-folding competition.

At least Motorola is providing a generous specification in return for your cash. The Razr 60 Ultra comes with 512GB of storage, the latest processor, a big 4,700mAh battery and fast charging. You also have a great range of new Pantone-branded finish options to choose from, namely Cabaret, Mountain Trail, Rio Red and Scarab – translating to a rich pinky purple, earth tones, maroon and opal green, respectively.

Aside from the new colours, Motorola deviates little from the established Razr design; the most visible change is the addition of the quick-access AI key on the left side. However, the hinge is now reinforced with titanium, making it feel snappier and more substantial. The crease in the middle of the display also seems shallower than ever – it's visible if you look for it, but not a distraction.

In all, the Razr 60 Ultra is a charming little thing. Despite the thin construction it feels sturdy, with a reassuring IP48 rating for protection against rain and accidental drops in the bath, although you'll still need to protect it from crumbs and dust.

Bright spots

The Razr 60 Ultra's main display is a 7in fold-out AMOLED panel. It looks great, with impeccable detail, wide viewing angles and bright colours. And I do mean bright: it peaks at a blazing 1,112cd/m² with SDR content but goes to a wear-sunglasses-to-protect-your-eyes 1,835cd/m² when viewing HDR films. It's a delight to use this phone in any conditions, and few rivals are capable of getting close to this level of luminance. Colour coverage is superb – well beyond 100% of the DCI-P3 gamut – and if the colours are too much then you can always switch to Natural mode.

As usual with flip handsets, the tall 22:9 aspect ratio might take some getting used to; it doesn't interfere with how I generally use a phone, but watching videos is odd as 16:9 media displays with gaps at the sides.

PC PRO RECOMMENDED

"It's a delight to use this phone in any conditions, and few rivals are capable of getting close to this level of luminance"

The outside display is a 4in OLED panel, which is also bright and detailed. As before, there are tons of personalisation options, and a selection of "flex modes" for when the phone's propped up on a desk.

Canny cameras

The Razr Ultra 2025 offers main and ultrawide 50MP cameras. I was happy with the images from both, which

came out with plenty of detail and natural-looking colours – more so than last year's Razr 50 Ultra (*see issue 360, p68*), which boosted the saturation too much for my liking.

Although there's no optical telephoto lens, the Razr 60 Ultra does a good job of digitally zooming in to 2x and even 4x magnification. You can even get away with pushing right up to the maximum 30x zoom, with captured images looking reasonably clear. I love the macro mode. Often, these are a waste of space, but the Razr 60 Ultra let me get close up to nature subjects and capture a huge amount of detail.

Its weakest suit is low-light photography: in dark environments, the phone had a tough time finding focus, and images came out visibly underexposed. I also question the point of the 50MP selfie camera embedded into the main display; this produces soft shots and is superfluous – you can just use the main rear camera, with the outer display as your viewfinder.

Content creators will enjoy the number of camera modes available, including additions such as Group Shot, which takes a burst of images and blends the best faces for idealised results. I also enjoyed using Pro mode to tweak the camera settings to my liking, but this is only for photos and not video.

On that note, video can be recorded at 4K 60fps or 8K 30fps – giving you an option to shoot at an ultra-high resolution, then crop in and reframe your footage before exporting it at 4K. With a wide field of view and good stabilisation, this phone is a great choice if you're looking for a pocket vlogging companion.

Full speed ahead

The Razr 60 Ultra is armed with a top-performing Snapdragon 8 Elite chipset and 16GB of RAM, making it the most powerful foldable phone around. I found apps and games ran perfectly, whether on the main or outer screen; an adaptive 165Hz refresh rate gives animations an extra fluid look.

Motorola's custom software runs on top of Android 15, but adds several major features, such as allowing you to run two apps simultaneously on the main display. I've always appreciated the way that Razr phones let you run any app on the outer screen too – it's ideal for one-handed use, with my sole grumble being that the camera lens sometimes gets in the way.

Meanwhile, the Smart Connect feature lets you connect wirelessly to other devices and share resources. It's genuinely useful, allowing you to access apps and files stored elsewhere, and I was even able to cast a virtual version of the phone onto my Windows 11 laptop.

Motorola's own-brand AI features include Catch Me Up (this uses AI to summarise your recent notifications), Pay Attention (a voice recorder that can transcribe and summarise recordings) and Remember This, which saves screenshots, photos and more for future reference. There are also powerful (albeit now commonplace) visual tools, which let you generate images from a text prompt, and turn quick sketches into detailed images.

Google Photos takes care of removing unwanted image elements and reimagining scenes, and the Google Gemini and Perplexity assistants are both built in, although they're free for a miserly three months.

The only disappointment is that Motorola offers a lowly three years of software support; that's less than half what you're promised with a similarly priced phone from Google or Samsung.

ABOVE The main 7in fold-out AMOLED panel is searingly bright

Snap decision

It's hard to believe that there's a 4,700mAh battery inside such a small phone – but there is, and paired with the power-efficient chipset it provides excellent longevity. Out of the box, with default settings, the Razr 60 Ultra lasted an excellent 15hrs 42mins of use on a single charge, and switching to the power-saving "Efficiency First" mode saw that shoot up to 18hrs 57mins.

The battery easily got me through an entire day, even a busy one. And when the time does come for a refill, the Razr 60 Ultra supports reasonably fast 45W wired charging; this took it to 40% capacity in 15 minutes and 72% after 30 minutes. Wireless top-ups are speedy, too, with support for 30W Qi charging.

"I haven't yet been persuaded to switch to a flip-phone, but the Razr 60 Ultra very nearly made me want to make the move"

LEFT The cameras are great for stills and excel at videos

I haven't yet been persuaded to switch to a flip phone, but the Razr 60 Ultra almost made me want to make the move. It's powerful, practical and compact, and it will run all day with ease. I also love the camera setup, which is superb for creators, and the new AI features.

What I'm torn about is the cost: at this price the Razr 60 Ultra is competing with mighty market leaders such as the Google Pixel 9 Pro (*see issue 362, p58*) and the Samsung Galaxy S25 Ultra (*see issue 357, p70*). But if you like the flip format, this is easily its best implementation yet. **JOHN VELASCO**

BELOW Can you see the join? Not unless you look closely

SPECIFICATIONS

8-core 4.32GHz/3.53GHz Qualcomm Snapdragon 8 Elite SoC • 16GB RAM • Adreno 830 graphics • Hexagon NPU • 6.9in foldable 120Hz AMOLED screen, 1,224 x 2,992 resolution • 4in AMOLED 165Hz cover screen, 1,272 x 1,080 resolution • 512GB storage • IP48 • dual 50MP/50MP rear cameras • 50MP selfie camera • 5G • Wi-Fi 7 • Bluetooth 4 • USB-C 2 connector • 4,700mAh battery • Android 15 (3yr OS updates) • open, 74 x 7.2x 172mm (WDH); closed, 74 x 15.7 x 88mm (WDH) • 199g • 1yr warranty

Dell 16 Plus 2-in-1

Mediocre battery life, but if you like the 2-in-1 format – or simply having a touchscreen – this is a good-value choice

SCORE ★★★★☆

PRICE As reviewed, £983 (£1,179 inc VAT) from dell.com

The first thing that strikes you on opening up the Dell 16 Plus 2-in-1 is its sheer scale. The 16in panel seems to stretch forever due in part to the slim bezels on either side, while a 357mm width means the keyboard deck has plenty of room for a number pad. Flip over the lid and you have a huge tablet on your hands, albeit one that weighs 2.1kg. You won't be carrying this around like an iPad but resting it on a table or your lap.

Why might someone want to buy a 16in 2-in-1 laptop? Reading through people's comments on previous such laptops on Dell's website, watching videos in tent format or as a tablet came up time and time again, while one customer mentioned how easy it was to use for presentations (again in tent mode). Another praised it as a virtual piano – the size helps here – while the majority simply enjoyed having a touchscreen and a big panel with a high resolution.

If a high resolution is important then make sure you buy the mini-LED version with a 2,560 x 1,600 resolution, which is what Dell supplied. You can choose a 1,920 x 1,200 IPS panel and drop the price to £999, but it will look grainy. That price also includes 16GB of RAM and a 512GB SSD, so you're making other sacrifices compared to the spec on test here. And if you're happy with 16GB of RAM, you might as well upgrade the panel anyway: the extra £80 also buys you a 1TB SSD.

It's a great display, too, covering 100% of the DCI-P3 colour space with a stupendous measured contrast ratio of 13,143:1. Unlike the eye-whacking panel on the Medion Erazer X1 Beast (*see p54*) it isn't overly bright, peaking at 439cd/m², but it does meet VESA's HDR600 specification – so will reach 600cd/m² in parts of the panel when viewing HDR content – and an average Delta E of 0.62 means you can trust its colour accuracy. This is a glossy panel, though, and I noticed spotlight reflections despite Dell's anti-reflective coating.

While the speakers won't win any hi-fi awards they're good enough to enjoy music on and there's enough bass to lend impact to high-octane films. Wannabe Spielbergs won't be shooting films using the 1080p webcam either – unless they want to recreate *The Blair Witch Project* – with over-saturated colours and compression both visible. But it's fine for the occasional video call, and the mics work well.

I have a couple of reservations over the keyboard, but then I switched to this after using the lovely Lenovo X1 Carbon (*see p52*). By contrast, the action feels stunted and the keys too easy to mis-hit; note the squashed cursors and the lack of space between the Return key (double-height, at least) and the number pad. In its defence, it's quiet and I found it easy to type fast on it with minimal errors. Dell also complements it with a huge trackpad, and there's plenty of space to comfortably rest your palms when typing.

The majority of ports – one Thunderbolt 4, one USB-C 3.2 Gen 2 and one HDMI 2.1 – sit on the left, with only a USB-A port and 3.5mm jack on the right. That seems wasteful given how much space there is, and I felt the same way when I removed the nine crosshead screws that keep the base in place: there's plenty of room for a second M.2 slot, although you can replace the existing one easily, and add a bigger battery. The latter would have been welcome, because the supplied 64Wh unit spluttered out after a mere 8hrs 38mins of light use.

That's a poor score when you consider that the Core Ultra 7 258V processor is built for efficiency. Still, Dell ekes all the speed you need from it, with fine returns in Geekbench and a solid 3,923 in 3DMark Time Spy thanks to the ever-impressive Arc 140V graphics. At 1080p, it produced 46fps in *Shadow of the Tomb Raider*, dropping to 33fps at the panel's native resolution, so there's gaming potential here.

It all adds up to a solid laptop, but I can't call it unexceptional because there aren't a tremendous number of 16in 2-in-1 convertibles out there to choose from. There are weaknesses – the battery life, the webcam, the keyboard – but it won't disappoint. It's also good value, but consider upgrading the single year of on-site warranty to four years by switching to Dell Care Plus: this adds £290 to the price, but replacing touchscreens can be costly if they go wrong. **TIM DANTON**

ABOVE The 16 Plus 2-in-1 has a superb touchscreen display

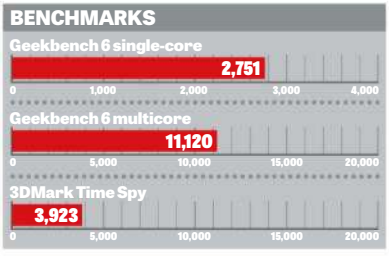
PC PRO RECOMMENDED

LEFT The panel's high resolution makes watching films a treat

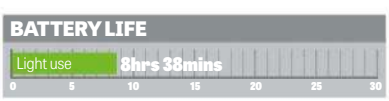
"It's a great display, covering 100% of the DCI-P3 colour space with a stupendous measured contrast ratio of 13,143:1"

BELOW With such a large screen, in tablet mode the 16 Plus isn't particularly portable

BENCHMARKS



BATTERY LIFE



SPECIFICATIONS

8-core (4 P-cores, 8 E-cores) Intel Core Ultra 7 258V processor • Intel Arc 140V graphics • 32GB LPDDR5X-8533 RAM • 16in 90Hz mini-LED touchscreen, 2,560 x 1,600 resolution • 1TB M.2 PCIe Gen 4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • HDMI 2.1 • Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • USB-A 3.2 Gen 1 • 3.5mm jack • 64Wh battery • Windows 11 Home • 357 x 250 x 17mm (WDH) • 2.1kg • 1yr on-site warranty • order code: cndb0625002

How we test

Laptops and PCs

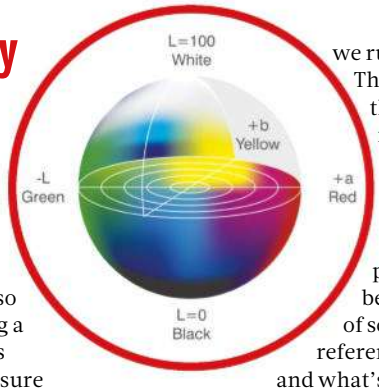
We run a selection of benchmarks on all the PCs and laptops we test. Where possible, we use a cross-platform test so we can compare Windows and macOS machines, which is where both Geekbench and Cinebench come into play. Both push the CPU to its limit, exposing how well cooled a system is.

We run extra tests for Windows systems. We use PCMark 10 to benchmark systems in office tasks, content creation and basic tasks such as web browsing and video calls. We also run 3DMark Time Spy and *Shadow of the Tomb Raider* as a minimum. We test laptops and PCs that include discrete graphics with a range of games, such as *Metro Exodus Enhanced* and *Dirt 5*.

For laptops, we test battery life with Wi-Fi on and the screen brightness set to 150cd/m². We fully charge the laptops and drain them until they reach 5%. For Windows laptops, we will use a mix of PCMark 10's light-use and video-based tests, or a web surfing benchmark where a laptop automatically visits sites until the battery dies. We also use this test for MacBooks.

ABOVE We put PCs and laptops through our intensive set of benchmarks

Screen quality



In each laptop, phone, tablet and monitor review, you'll see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a X-Rite Display i1 Plus colorimeter. We measure maximum brightness, colour accuracy and (for monitors) consistency – there may be a difference in, say, brightness from the middle and the edges of the panel.

We also measure Delta E, which is a guide to how accurately panels display colours. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.

LEFT We use a Display i1 colorimeter to measure sRGB gamut coverage and Delta E

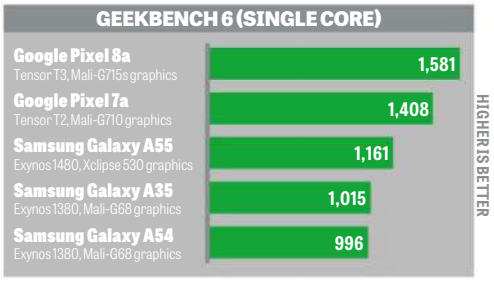
Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we review. First, we run Geekbench 6. This is a good test of the processor and memory in particular, and include both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run 3DMark Wild Life test to give a measure of gaming performance.

We test tablet battery life by playing a full-screen video until the battery runs out with the device. To simplify the test, we use Airplane mode. We set the brightness to as close to 150cd/m² as we can get in the device's settings. We also put phones through a set of real-world and labs-based tests.

BELOW We play a video with the screen set to 150cd/m² to test battery life



What our awards mean

Recommended
This, quite simply, is a product we recommend you buy – if it meets your needs.

A-List
The best buy in its category right now. The product will also feature on our A-List, starting on p14. It's updated each month.

Labs Winner
Each month we run a group test, or Labs. This product has managed to beat all others to top position.

Tinyurl.com links

Throughout the magazine you'll see **tinyurl.com** shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we may have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper then we will use that instead.

Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change, especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

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SCAN

Lenovo ThinkPad X1 Carbon Gen 13

A compelling evolution of the demanding executive's favourite laptop, with its quality undimmed by time

SCORE ★★★★★

PRICE As reviewed, £2,000 (£2,400 inc VAT) from lenovo.com

This is the first laptop that's made me feel old. Is the X1 Carbon really turning 13? It remains an outstanding 14in ultraportable, but you need to give it a close examination to spot the differences to last year's model.

But there are differences, all of them positive. First, it's even lighter at 1kg rather than 1.1kg. Second, it now includes Core Ultra 200V series processors, bringing support for Microsoft's Copilot+ PC scheme. Third, the SSD has been upgraded from Gen 4 to Gen 5, and that means astonishing 13,588MB/sec sequential writes and 10,403MB/sec reads.

The IPS panel also gains a minor upgrade, pushing up to a stated 500cd/m² maximum compared to 400cd/m², and my review sample peaked at 501cd/m². It's geared towards energy efficiency over zinging colours, with 97% coverage of the sRGB gamut and only 71% of DCI-P3, but you're rewarded with excellent colour accuracy and a true working day of battery life. In our light-use tests, it lasted an average of 18hrs 56mins with the screen at 150cd/m² – I used it at higher brightnesses, as whites look whiter.

You'll sacrifice 3-4 hours of battery life if you upgrade to the OLED panel, but at £90 that's worth doing if you intend to watch films. They'll still look good on this IPS matte screen, but the OLED panel covers 100% of the DCI-P3 space (Lenovo claims) and colours will jump out more. The other benefit is a 2,880 x 1,800 resolution compared to 1,920 x 1,200. You lose the IPS panel's touch capabilities, however.

Battery life will also vary depending on the processor. Lenovo has just announced that the X1 Carbon Gen 13 will include Core 200U and Core 200H chips in the future, with the former geared towards efficiency and the latter towards power. I still think the 258V (choose the otherwise identical 268V if you want vPro support) is a great choice for the target audience of this laptop. Sure, it only has eight cores and that means it will never shine in benchmarks, but it feels punchy in day-to-day use and slices through office applications.

Intel's Arc 140V graphics give respectable levels of acceleration in games (43fps at the panel's native resolution in *Shadow of the Tomb Raider*, albeit at Low settings) but can also be called upon in apps such as Affinity Photo for hardware acceleration. Its power is reflected in the 4,197 return in 3DMark Time Spy, which is as good as it gets for an integrated GPU.

Beyond its speed, you'll enjoy everything that has always made the ThinkPad X1 Carbon such a treat to use. Top of that list is the crisp keyboard, with plenty of travel despite the chassis' narrow dimensions, and an exemplary layout: separated cursor keys, huge Return, plus the keys have the tiniest dip in the middle to avoid slippage. Lenovo's attention to detail is also evident in bevelled corners to make mis-hits less frequent. The trademark red Trackpoint remains, but the top of the haptic touchpad substitutes for the physical buttons that used to accompany it. I find it an excellent compromise.

Lenovo still finds space for all the connections you'd expect, with two USB-A ports, two Thunderbolt ports, a 3.5mm jack and an HDMI 2.1 output.

Last year's model benefited from an upgraded webcam built into the lip at the top of the screen – this also makes the lid easier to open – and it's again on show here. I tested the 8MP version and it's simply the best webcam I've seen on a laptop, with exceptional colours and detail, especially at 1440p. It's matched with an excellent dual-microphone array and solid speakers; the X1 Carbon lacks bass but won't destroy your favourite tracks.

Corporate buyers will also appreciate Lenovo's efforts to tick ESG criteria, including the use of recycled materials and no wasteful packaging. It scores an EPEAT Gold rating as a result. Lenovo also makes it easy to access the inside – undo four captive crosshead screws and you're in – and provides easy-to-follow guides on how to replace the battery, SSD and more. As ever with Intel's Core Ultra 200V chips, the RAM is integrated into the package.

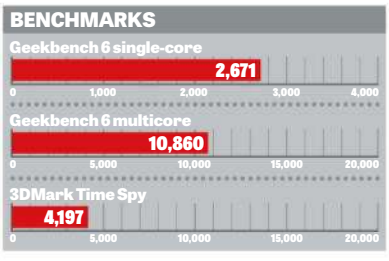
All this quality comes at a price. The cheapest version of the X1 Carbon Gen 13 Aura Edition (don't get excited by the "Aura Edition" as it's fundamentally a marketing partnership with Intel) costs £2,249 including VAT, with a 258V chip and 512GB SSD. Still, that includes a three-year warranty, and once the laptop is delivered it's obvious that your money has been well invested. It's too expensive for mass rollouts, but I can't fault it as an executive laptop. **TIM DANTON**

ABOVE The ThinkPad X1 Carbon has all the attributes of a superb executive laptop

PC PRO RECOMMENDED

"Beyond its speed, you'll enjoy everything that has always made the ThinkPad X1 Carbon such a treat to use"

LEFT The keyboard is up to Lenovo's usual high standards



BELOW It has all the connections you'd expect, including two Thunderbolt ports

SPECIFICATIONS

8-core (4 P-cores, 8 E-cores) Intel Core Ultra 7 258V processor • Intel Arc 140V graphics • 32GB LPDDR5X-8533 RAM • 14in 60Hz IPS touchscreen, 1,920 x 1,200 resolution • 1TB M.2 PCIe Gen 5 SSD • Wi-Fi 7 • Bluetooth 5.4 • 8MP IR webcam • HDMI 2.1 • 2 x Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 1 • 3.5mm jack • 57Wh battery • Windows 11 Pro • 313 x 215 x 15mm (WDH) • 1kg • 3yr C&R warranty

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Medion Erazer Beast 16 X1 Ultimate

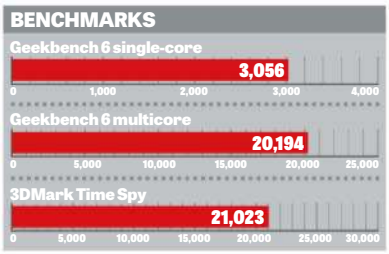
Not the most refined gaming laptop, but with RTX 5090 graphics at RTX 5080 prices it's the best value of the latest crop

PC PRO RECOMMENDED

SCORE ★★★★☆

PRICE £2,917 (£3,500 inc VAT) **from scan.co.uk**

Chances are that you've heard of the Medion brand. It's a division of Lenovo, which bought a controlling stake in the German company in 2011. You'll find Medion's gaming laptops in a range of British online retailers, and its prices are often among the most competitive. As it is here. The Erazer arrived too late to be included in our Labs mini of gaming & creative laptops on p68, but at £3,500 it's £499 cheaper than the HP Omen Max 16.



In terms of specification, the Beast follows the same pattern as every other big-framed gaming laptop of 2025. Intel's Core Ultra 9 275HX processor has become the de facto choice for this bulky breed, which makes sense: not only does it pack 24 cores, but its single-core performance is excellent as games demand. And as eight of those cores are geared towards performance, when you're faced with core-heavy tasks these laptops effectively laugh with joy. By which I mean that the fans kick in.

The only limitation is here 32GB of RAM; demanding users who want 64GB will have to replace the two supplied 16GB DIMMs. This is one area where the HP Omen wins, as it supplies 64GB as standard.

Easy upgrades

We're also seeing PCIe Gen 5 SSDs become the standard choice for top-end PCs and laptops, and so it is here, with Medion opting for an incredibly fast 2TB drive. It hit 9,685MB/sec sequential writes and 7,624MB/sec reads in CrystalDiskMark 8, which is roughly double the speeds of a high-quality Gen 4 SSD. There's even space for a second drive, albeit Gen 4. You have to fight past 12 crosshead screws to access this, and another three to remove the heatsink, but to have up to 4TB of storage in a laptop is surely worth the hassle.

All the heatsinks are finished in matte black, making the inside of this laptop arguably more stylish than the boring grey metal of the chassis. Style aside, the heatsinks make sense as there's a lot of silicon to cool: Nvidia's top-end GeForce RTX 5090 mobile GPU includes 45.6 billion transistors all on its own.

ABOVE Medion's Erazer Beast lives up to its name in games

BELOW Medion offers an optional water cooling unit for frame-rate fanatics

Blistering pace

Two fans draw the heat away, and in general they did an excellent job. If the Erazer had been in our Labs mini then it would have topped the table for *Shadow of the Tomb Raider* (190fps) and *Borderlands 3* (188fps). Likewise in 3DMark Speed Way and Port Royal, where it scored 6,015 and 14,855 respectively. Medion doesn't quote how many watts it supplies to the RTX 5090 graphics, but this suggests the peak of 175W.

Still, it wasn't a clean sweep. The Beast was mid-table for *Cyberpunk 2077* (61fps), *Black Myth: Wukong* (61fps) and *Far Cry 6* (110fps). As with all the RTX 50 series, though, you have DLSS 4 and AI frame generation to call upon to boost those frame rates. And I should mention that while all those results are at 1080p, almost every setting is pushed to the maximum with no help from DLSS.

When I used less horrific presets at the screen's native resolution of 2,560 x 1,600, it rarely fell below 100fps. To give you a sample, *Dirt 5* played at 151fps using the Ultra high preset, *Cyberpunk* 72fps in RT Ultra, and *Borderlands 3* averaged 125fps with Ultra settings.

Everyday experiences

It was a similarly strong story in the productivity tests, with this being only the second laptop we've reviewed that broke the 20,000 mark in Geekbench 6's multicore test – but its single-core result of 3,056 was a fraction behind the best. Still, that's delving into the realm of numbers for numbers' sake, and where it matters I'm confident that you'll never be disappointed by this laptop's performance. For example, Cinebench 2024 is an excellent test of multicore speed, and the Beast lived up to its name with a 1,260 result.

The fans only tend to kick in during games, but if you find them irritating then you should fire up Medion's Control Center software. This isn't as refined as Asus' Armoury Crate or HP's Gaming Hub, but all the usual controls for fan profiles are here (there's also a shortcut button above the keyboard that cycles through them). It's also where you can take control of the RGB lighting on the keyboard, down to individual keys, plus the light bar that sits on the front.

If there's a way to control the colour of the light of the Medion logo on the rear of the laptop's lid then I couldn't find it, which is a shame as it screams gaming laptop when you may not always want to.

ABOVE **Three USB-A and two USB-C ports are among the laptop's connectivity options**

Bulky design

Then again, unlike the slimline Razer Blade 16 (*see issue 369, p58*), the Beast isn't trying to be anything other than a gaming laptop. It's a meaty 360mm wide, 245mm deep and 30mm thick, and that doesn't include the protruding feet (needed for airflow to the bottom of the chassis). And while its light-use battery life of 6hrs 41mins is respectable, likewise 1hr 50mins in PCMark's gaming test, at 2.7kg this is a machine built for occasional travel rather than daily trips into the office.

That battery life is particularly good considering the quality of the mini-LED panel, which produces impactful colours and strong whites. And, unlike OLED panels, it shines bright, peaking at 838cd/m². With 100% coverage of the DCI-P3 gamut and good colour accuracy – so long as you avoid the Vibrant mode – this is a versatile display whether for gaming, daily use or films. The speakers are fine, but I would have liked woofers in a laptop this big to add balance and bass. As for the 1080p webcam... arguably its best feature is the privacy cover.

"Battery life is particularly good considering the quality of the mini-LED panel, which produces impactful colours and strong whites"

Key decisions

I have mixed feelings about the keyboard. I like its clipped switch mechanism, and I'm sure gamers will appreciate them too, but as Medion squeezes in a number pad space is at a premium. Although it does supply the largest Return key (and Copilot key, oddly) I've seen, while the cursor keys are well separated.

The touchpad is smaller than I expected on a 16in laptop, but with three USB-A ports spread across the left and right side you can add your favoured gaming mouse.

You'll also find a full-size SD card reader, 3.5mm jack, USB-C port and 2.5GbE port, but it's at the back where things get interesting. Sensibly, in terms of cable management, this is where the 420W power brick plugs into, along with an HDMI 2.1 port, a second USB-C port and connectors for the optional water cooling kit. I'm not a fan of these, as they offer little extra speed in return for many cables and lots of mess, but others have a different view.

Ultimately, what makes this laptop worth considering is its price. Its closest matchup in the Labs mini is the HP Omen 16, which is far more refined but also considerably more expensive. HP also has a more robust UK presence than Medion (its website is very basic), and be aware that if something goes wrong with it then you'll need to send it back to Germany for repair. However, there's no arguing with its value for money: an RTX 5090 laptop at this price is a steal. **TIM DANTON**

LEFT **The keyboard has a number pad, but the touchpad is smaller than you might expect**

SPECIFICATIONS

24-core (8 P-cores, 16 E-cores) Intel Core Ultra 9 275HX processor • 24GB Nvidia GeForce RTX 5090 graphics • 32GB DDR5-5600 RAM • 16in non-touch mini-LED display, 300Hz, 2,560 x 1,600 resolution • 2TB M.2 PCIe Gen 5 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1 x Thunderbolt 4/USB-C 3.2 Gen 2 • 1 x USB-C 3.2 Gen 1 • 3 x USB-A 3.2 Gen 1 • HDMI 2.1 • DisplayPort 2.1a • SD card reader • 2.5GbE • 3.5mm combo jack • 99Wh battery • Windows 11 Home • 357 x 245 x 30mm (WDH) • 2.7kg • 2yr RTB warranty • part code: 30039609

BELOW **The bright mini-LED panel is ideal for gaming, working or watching films**

Medion Erazer Hunter X30

A solid first outing from the German manufacturer, but the price must drop to earn a Recommended award

SCORE ★★★★☆

PRICE £2,083 (£2,500 inc VAT)
from box.co.uk

There are two main routes to buying a gaming PC. The first is to choose a custom-builder such as CyberPowerPC (*see p58*). Such companies have a base in the UK where they build systems to order, right down to the type of thermal paste. The second is to buy a pre-assembled PC, either from a British manufacturer or familiar names such as Acer and HP. Or less familiar names such as German manufacturer Medion, a division of Lenovo.

This is my first look at its line of Erazer Hunter X30 gaming PCs, and I was immediately struck by its design. Looked at from the front, the lower two-thirds resemble a speaker thanks to the metallic grille, with the top third finished in blackened glass. It arguably looks nicer switched off: when on, the Erazer antler-like logo glows through the top, while the bottom is dominated by two RGB fans. On or off, though, it's attractive, while the chassis is relatively compact at 210mm wide and 445mm tall.

A tempered glass panel stretches all the way down the left hand-side, lending a dark tint to this PC's innards. My eye was inevitably drawn to the graphics card: here, a GeForce RTX 5080, although you can buy configurations of the Hunter X30 with different cards. This one includes a hint of RGB, but only to show off the GamingPro logo of its manufacturer. More RGB emanates from the single rear fan, two 16GB sticks of Kingston Fury Beast RGB memory and a subtle backlit "GAME ON" etched onto the edge of the motherboard. That's next to a far less subtle orange LED, to show the motherboard has power.

ABOVE **This is a solid gaming PC that comes at a competitive price**

I like the darker than usual tint on the side panel glass, but the RGB here doesn't do it justice. Perhaps it would help if Medion supplied its own control software rather than relying on Gigabyte's Control Center software; that only detected the memory, although I was told that it should have detected the other RGB lighting too. It's also odd that Medion doesn't install more fans. You can get away with one rear fan to accompany a liquid cooling system with lesser graphics cards, but I soon noticed the warmth of the Hunter X30 sitting next to me on my desk. It always produces a low hum, too; not annoying, but ever-present in a way that PCs with more fans tend to avoid (as they don't need to run so fast).

The two front-mounted fans, attached to the liquid cooler, kick into aggressive action when the CPU is pushed, as happened within around ten seconds of Cinebench 2024's multicore test starting. In return, you'll enjoy excellent performance, with its 2,032 result a fraction ahead of the CyberPowerPC Infinity Z890 Air (*see issue 368, p61*), which features the same CPU, and the Hunter X30 beat it by almost 1,000 points in Geekbench 6's multicore section.

But it's gaming performance that most people will care about, and the RTX 5080 lives up to its reputation. We've toughened up our gaming benchmarks this month, so the following aren't comparable with previous months: instead, they reflect what you'll get with the hardest settings and no DLSS. Bearing that in mind, 4K averages of 105fps in *Shadow of the Tomb Raider*, 154fps in *Dirt 5*, 113fps in *Borderlands 3* and 112fps in *Far Cry 6* are all admirable. A 34fps result in *Cyberpunk 2077* sounds less impressive, but switching to its RT Ultra preset (which includes DLSS and Frame Generation) produced 87fps.

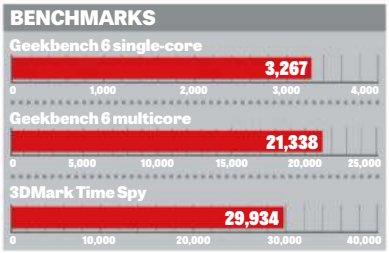
You can upgrade to an RTX 5090 in the future, as the supplied 1,000W PSU meets Nvidia's minimum criterion. But at that point you will surely need to invest in fans, and there isn't much space in the chassis for them; only at the bottom, but then you risk blocking the two empty PCIe x4 slots that currently sit vacant. Not that there's much need for add-in cards, with the Gigabyte Z890 Eagle Wi-Fi 7 motherboard offering fast networking and connectivity – 2.5GbE LAN and a USB-C 4 port are the speediest inclusions – along with four M.2 slots. One of these supports Gen 5 cards, but you're out of luck here with a Gen 4 WD Black SN 770 in place (5,210MB/sec reads, 4,835MB/sec writes). It's easy to add 2.5in and 3.5in drives, too, with disk caddies accessible from the left-hand side; no need to unscrew the right-hand panel.

"Where does this leave the Hunter? Somewhere in the middle of the pack. The price is competitive but not astounding"

So where does this leave the Hunter? Somewhere in the middle of the pack. The price is competitive but not astounding: you can buy RTX 5080 PCs with a similar configuration for this price elsewhere. For me to recommend it over a British-made PC, or one from its international rivals, it would need to offer exceptional value or speed. At £2,500 it's a solid buy, but no more. **TIM DANTON**

BELOW **The strikingly designed Hunter X30 is compact and potent**

BENCHMARKS



SPECIFICATIONS

20-core (8 P-cores, 12 E-cores) Intel Core Ultra 7 265KF processor • Gigabyte Z890 Eagle Wi-Fi 7 motherboard • 32GB Kingston Fury Beast RGB DDR5-6400 RAM • 16GB Nvidia GeForce RTX 5080 graphics • Alphacool Eisbaer 240 AIO liquid cooler • 2TB WD Black SN 770 PCIe Gen 4 SSD • Erazer Hunter X30 chassis • 1,000W Seasonic Vertex GX-1000 80 Plus Gold PSU • Windows 11 Home • 210 x 476 x 445mm (WDH) • 2yr RTB warranty • power: 100W idle, 562W peak

Alienware Area-51 Gaming Desktop (2025)

This behemoth of a gaming PC oozes class while extracting the most from its expensive components

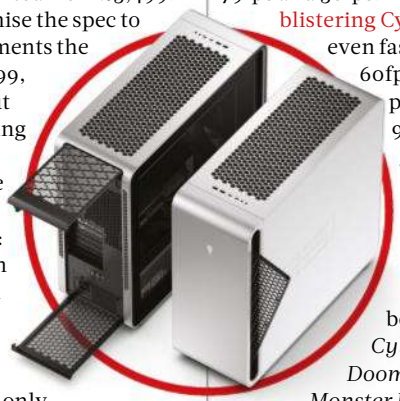
SCORE ★★★★½

PRICE As reviewed, £4,041 (£4,849 inc VAT) from dell.com

The Alienware Area-51 is easily the heaviest gaming PC I've tested: 34kg. I couldn't even lift it up onto the desk on my own. And its giant size isn't merely for show, as it packs equally powerful components inside its futuristic frame.

Photos don't do this all-aluminium chassis justice, with elegant curves, hexagonal vents and a side-to-side transparent panel. With RGB lighting on its front sides, and an Alienware logo-shaped power button, this PC makes a statement.

But Dell is making you pay. Its starting price of £3,799 only includes a GeForce RTX 5080; if you want the 5090, you'll pay a minimum of £4,849. That price is discounted from £5,499: if you want to customise the spec to your exact requirements the price starts at £4,999, with the maxed-out configuration costing an epic £6,299.



Fortunately, the supplied selection is largely excellent: who can argue with a Core 9 Ultra 285K processor, 64GB of DDR5 RAM and a GeForce RTX 5090 graphics card? The only bum note – and calling it that is a stretch – is the inclusion of a 2TB Gen 4 SSD rather than Gen 5. But the main M.2 socket is Gen 5, so you can swap the supplied SSD into one of the two vacant M.2 sockets, or pay the premium for a Gen 5 SSD at the time of purchase.

Not that this held the Area-51 back. My most demanding workload is to edit and export images in GIMP, which is as nothing to this PC. The graphs below tell their own story, but I can tell you that it sliced through our HandBrake encoding test in 1min 53secs. That's one of the fastest results we've seen and a reflection of the potent 24-core processor.

Using its tough Cinematic settings, *Black Myth: Wukong* returned 102fps at 1080p and 50fps in 4K. Compare that to the Erazer Hunter X30 with 79fps and 38fps. However, the blistering CyberPowerPC was even faster with 110fps and 60fps, thanks at least in part to its Ryzen 9 9950X processor. In general, this always meant the Dell was a few frames per behind across our range of titles.

Away from benchmarks, I played *Cyberpunk 2077*, *Doom Eternal* and *Monster Hunter Wilds* at 4K and maxed graphical settings with DLSS turned off. *Doom Eternal* was the big winner, running at an insane 220fps to 236fps. *Monster Hunter Wilds* also ran like a dream at 75fps to 90fps, and *Cyberpunk 2077* ran great at 66fps to 75fps.

You'd think a huge gaming PC such as this would roar as loud as a jet engine. Thankfully, that isn't the case due to the impressive "positive pressure" airflow system. Instead of exhaust fans that blow hot air out, all fans intake and blow cool air inward, from the front, top and bottom, to create positive air pressure that pushes hot air out of the rear vents. Alienware says this system has 25% improved airflow over past gaming PCs.

Marketing spiel aside, the Area-51 runs quietly, even when playing games with cranked-up settings. I could barely hear its fans, and the rear vents remain relatively cool to the touch. This is one of the most remarkable aspects of this PC.

Opening the Area-51 PC is extremely easy. Simply turn a dial on the rear from lock to unlock and then press the button for the side panel you want to release. It's one of the smartest methods of removing a PC's panels I've experienced. And thanks to the PC's spacious interior, you won't have much trouble moving your hands around inside.

The Alienware Area-51 mostly uses industry-standard parts, with the exception being the proprietary motherboard. If you want to upgrade this, you'll need to buy a £41 AlienFX board cable conversion kit from Dell.

You get a full array of ports here. On top, you'll find a pair of USB-A ports, two USB-C ports, a headphone jack and a line-out port. Most of the ports reside on the rear, including four USB-C ports, five USB-A ports, an optical audio port, line-in and line-out ports, and an Ethernet port.

There's no denying how expensive the Alienware Area-51 is: you can save almost £1,000 by opting for the CyberPowerPC, which was also faster in benchmarks. But the Area-51 is a beautiful machine that will bring class to any gaming den or home office, and the almost complete lack of fan noise is something you'll appreciate every day you own it. **TONY POLANCO**

ABOVE The Area-51 packs some powerful components into its futuristic frame

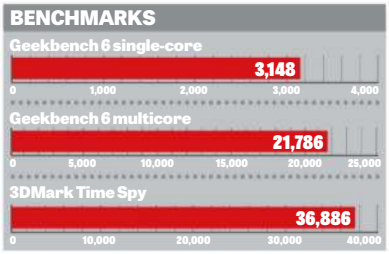
PC PRO RECOMMENDED

"You'd think a huge gaming PC such as this would roar as loud as a jet engine. Thankfully, that isn't the case"

LEFT Elegant curves, hexagonal vents and a transparent panel make a real statement

BELOW The aluminium chassis looks great, but you'll need help lifting it onto a desk

BENCHMARKS



SPECIFICATIONS

24-core (8 P-cores, 16 E-cores) Intel Core Ultra 9 285K processor • Dell custom motherboard • 64GB DDR5-6400 RAM • 24GB Nvidia GeForce RTX 5090 graphics • Dell custom AIO liquid cooler • 2TB PCIe Gen 4 SSD • Alienware Area-51 chassis • 1,500W Dell custom Platinum PSU • Windows 11 Home • 232 x 611 x 569mm (WDH) • 1yr on-site warranty • power consumption not tested • order code: aat2250_cto5

CyberPowerPC Ultra 3D5090

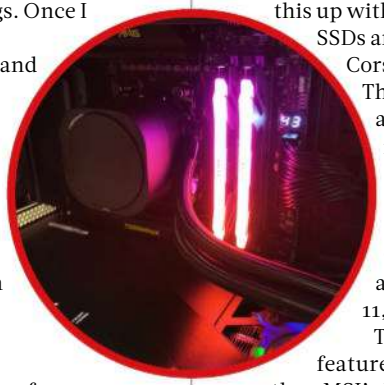
The best gaming chip and graphics card combine with predictable power: if you refuse to compromise, buy it

SCORE ★★★★★

PRICE £3,333 (£4,000 inc VAT)
from tinyurl.com/370cyber

Tina Turner's song springs to mind: by choosing the AMD Ryzen 9 9950X3D processor and Nvidia GeForce RTX 5090 graphics, CyberPowerPC has opted for simply the best gaming components. They have proven, through exhaustive benchmarking, to be better than all the rest. The question is whether this combination will give you everything you need.

If you're a gamer, then the simple answer is yes. Across the six games I tested with, at ludicrously tough settings with no assistance from DLSS 4, it only dipped below 60fps once: and that was by 1fps in *Cyberpunk* with RT Ultra settings. Once I re-activated DLSS, it zoomed up to 132fps and looked as smooth as could be. The only other time this PC fell close to 60fps was in *Black Myth: Wukong* at Cinematic 4K. Dropping to Medium settings, which still look amazing, it averaged 109fps.



In every single one of my other tests, the CyberPowerPC Ultra 3D5090 sat comfortably in the three-figure range, with notable highlights – at 4K without DLSS, remember – being 173fps in *Far Cry 6*, 183fps in *Borderlands 3*, 172fps in *Shadow of the Tomb Raider* and 241fps in *Dirt 5*.

This isn't a one-trick pony, however, as the AMD Ryzen 9 9950X3D is effectively AMD's fastest desktop processor – wielding 16 performance cores and 32 threads – but with extra cache to boost its speed in games. All those cores mean that it's similarly fast in demanding tasks, as a multicore result of 2,337 in Cinebench 2024 reveals. It's worth flagging that its single-core speed is again exceptional, with 139 in Cinebench and a top-tier 3,428 in Geekbench 6.

CyberPowerPC – a US company with a British base in the UK – backs this up with one of the fastest SSDs around, the 2TB Corsair MP700 Pro. This is a Gen 5 drive and that means no bottlenecks: it returned 12,384MB/sec sequential reads in CrystalDiskMark 8 and writes of 11,269MB/sec.

There are more feature-laden offerings than MSI's MAG X870E Tomahawk Wi-Fi motherboard, but it's an excellent foundation for such hardcore components as it uses AMD's best X870E chipset. That also means there's no shortage of PCIe lanes (44) if you intend to add extra PCIe cards or SSD drives. That said, the huge MSI graphics card blocks access to all but one PCIe slot, and you'll need to remove this card to access the two M2 slots (both Gen 4) at the bottom of the board, with one Gen 5 M.2 slot vacant above it – but again it's tricky to access. There are also two empty 3.5in hard disk bays and two holders for 2.5in SSDs, all accessible by removing the right-hand panel (tool-free) of the understated but high-quality Lian Li Lancool 216 RGB chassis.

The simplest upgrade of all is to the memory. CyberPowerPC chooses the RGB variant of Kingston's Fury Beast memory, with a pair of 16GB sticks leaving two sockets free. Aside from the pair of 160mm front-mounted fans – which come as standard with the Lian Li case – that's it for RGB. There are also three non-RGB fans as part of Corsair's liquid cooling system, but don't imagine this is a noisy system: 95% of the time it will sit there making a barely noticeable whirr, and it's only when you start gaming that you'll notice an uptick. Even then, it isn't bothersome.

It certainly doesn't reflect the power ratings here, with a 1,250W PSU and a peak power consumption of 957W during our tests. Even at idle it demands over 100W, so it makes sense to put this PC into standby after a short period of inactivity or that power bill will start to add up.

There are three final things to point out. One is the five-year warranty, with the first two years including parts and no charge for shipping in the first year. You can upgrade this at the time of purchase (£99 for three years parts and shipping), and that brings me to the second point: everything here is upgradable, or indeed downgradable. Dropping to an RTX 5080 saves you £654, for instance. Personally, I would opt for a second 2TB SSD (for an extra £187) at the time of purchase to save hassle when you actually need it. And the third point is that you'll have to wait for this PC to arrive, with build times listed at just under two weeks at the time of review.

There's no hiding from the price of the CyberPowerPC Ultra 3D5090, but like Tina on the big stage it doesn't put a foot wrong. **TIM DANTON**

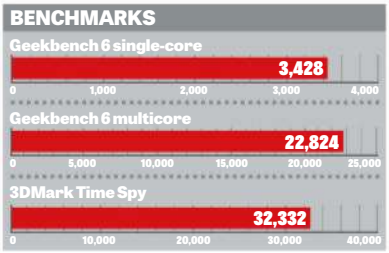
ABOVE **The Ultra 3D5090 packs the best CPU and graphics card combo around**

PC PRO RECOMMENDED

"This isn't a one-trick pony, as the AMD Ryzen 9 9950X3D is effectively AMD's fastest desktop processor"

LEFT **Unusually for a gaming PC, RGB lights are understated**

BELOW **The stylish Lian Li chassis is far quieter than the fans make it look**



SPECIFICATIONS

16-core/32-thread AMD Ryzen 9 9950X3D processor • MSI MAG X870E Tomahawk Wi-Fi motherboard • 32GB Kingston Fury Beast RGB DDR5-6400 RAM • 32GB MSI GeForce RTX 5090 Gaming Trio OC graphics • Corsair Nautilus 360 RS AIO liquid cooler • 2TB Corsair MP700 Pro PCIe Gen 5 SSD • Lian Li Lancool 216 RGB chassis • MSI MAG A1250GL 80 Plus Gold PSU • Windows 11 Home • 235 x 481 x 492mm (WDH) • 5yr warranty (1yr C&R, 2yr parts) • power: 108W idle, 957W peak

MSI Pro AP272P

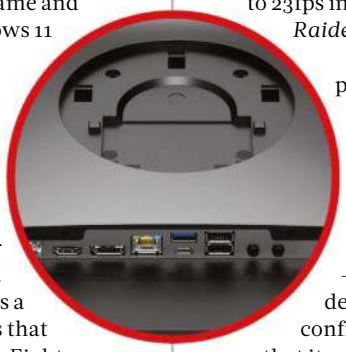
A questionable choice of processor and panel undermine its excellent connectivity and webcam

SCORE ★★★☆☆

PRICE £858 (£1,030 inc VAT)
from laptopsdirect.co.uk

Given the popularity of Apple's iMac range, it seems odd that the all-in-one Windows PC has never hit similarly heights. There's an extremely limited choice of system for buyers, which means that when a company such as MSI – the Taiwanese manufacturer best known for its gaming laptops and motherboards – offered me the chance to review its latest offering I grab it with both hands.

There are two points of difference here compared to, say, the Dell Inspiron All-in-One (*see issue 350, p47*). The first is that MSI is targeting professional buyers, as indicated by "Pro" in the product name and the inclusion of Windows 11 Pro rather than Home. The second is that it opts for desktop rather than mobile processors, with a Core i7-14700 inside this model and a Core i5-14400 in its cheaper sibling (£830 inc VAT).



As a result, this PC is a fine performer in tasks that demand many threads. Eight P-cores and 12 E-cores mean that it will be particularly strong when tackling tasks such as video-editing or data processing, as reflected by a 12,398 result in Geekbench 6 and 880 in Cinebench 2024; by contrast, one of Intel's mobile Core 7 Ultra chips typically returns around 11,000 and 600 respectively in those multicore tests. If you decide to buy the Core i5 version of this machine – with six P-cores and four E-cores – then I'd expect it to drop to roughly the same level as a Core 7 Ultra.

That's all fine, but by choosing a 14th-generation Core desktop CPU you're missing out on an integrated neural processing unit (NPU), so forget about features that rely on local AI – and Microsoft's Recall in particular.

More immediately aggravating, especially for those who like to play graphically demanding games or use apps that need GPU acceleration, is that the integrated Intel UHD Graphics 770 chip is old-school: 930 in 3DMark Time Spy is the worst score I've seen this year, and at 1080p and lowest settings the MSI Pro AP272P struggled to 23fps in *Shadow of the Tomb Raider* and 18fps in *Dirt 5*.

Factor in the extra power demands of a desktop chip – this all-in-one demanded 103W at peak while emitting a substantial amount of heat from its vents – and I question MSI's decision to opt for this configuration. I hoped that it might make the system easier to upgrade, but while the manual says that some components "may be upgradable", you're advised to "contact the local dealer". I couldn't find an obvious way to break into the rear, so I suspect that most buyers will have to make do with the supplied 16GB of DDR5-4800 RAM and 1TB SSD. And hope that it doesn't fail outside of its one-year warranty.

The SSD isn't fast by modern standards, returning sequential reads and writes of 3,507MB/sec 3,345MB/sec in CrystalDiskMark, but that should be enough storage for this PC's lifetime. If you need more then your best bet is the single USB-C port at the rear: this supports USB 3.2 Gen 2 (10Gbits/sec), as does one of the five USB-A ports. Well, supposedly: on testing, I found all the USB-A ports to be similarly slow. Two are conveniently located at the side of the display, while the rest sit next to the 1GbE port, HDMI 2.1 and DisplayPort outputs and pair of 3.5mm jacks. Along with Wi-Fi 6E, that's respectable levels of connectivity.

I suggest you use the line-out or built-in Bluetooth, as the speakers aren't good enough for listening to music. Perhaps more importantly for professional users, MSI provides a high-quality 1080p IR webcam, which is great for video calls. It would have been even better if it had been tiltable rather than fixed in place above the top bezel, but instead you'll have to tilt the whole screen. MSI doesn't state the range but I'd guess –5° to 15°, which, along with around 100mm of height adjustment, makes this a more flexible all-in-one than the Dell. There's no swivel, but it's light enough for that not to be an issue.

Then we come to the 27in IPS panel, which is arguably the biggest disappointment of this otherwise good-quality all-in-one. When paying this much, I expect rich colours, great colour accuracy and clean whites. Tackling those in order, it covers 91% of the sRGB space and 70% of DCI-P3; okay, but definitely not rich. Colour accuracy is fine, with an average Delta E of 1.12 and worst result of 4.01. But whites are poor, as reflected by a colour temperature of 5688K. You can fiddle around using third-party apps, but there are no built-in controls other than brightness, taking it to a mediocre maximum of 289cd/m². Also note that it only has a 1,920 x 1,080 resolution, which is okay on a 24in panel but leads to grainy edges on text here.

There are things MSI gets right. The webcam, the fine connectivity (two video outputs add welcome options, and Wi-Fi 6E is good to see), the flexible stand. But I can see no benefit in choosing a desktop chip with weak integrated graphics over mobile rivals, while the deeply mediocre 27in panel steals away any hope of an award. **TIM DANTON**

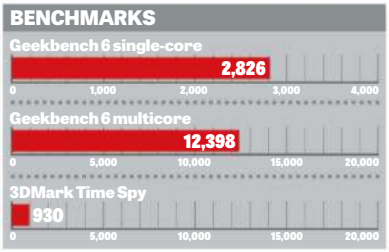
ABOVE The MSI Pro AP272P is hampered by a weak CPU and disappointing display

"I can see no benefit in choosing a desktop chip with weak integrated graphics over mobile rivals"

LEFT Connectivity is good, with five USB-A ports and one USB-C

BELOW You'll have to tilt the whole screen to make the most of the excellent webcam

BENCHMARKS



SPECIFICATIONS

20-core (8 P-cores, 12 E-cores) Intel Core i7-14700 processor • Intel UHD Graphics 770 • 16GB DDR5-4800 RAM • 27in 100Hz IPS non-touch panel, 1,920 x 1,080 resolution • 1TB M.2 PCIe Gen 4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1GbE • 1080p IR webcam • HDMI 2.1 output • DisplayPort 1.4 output • USB-C 3.2 Gen 2 • USB-A 3.2 Gen 2 • 4 x USB-A 2 • 3.5mm mic in • 3.5mm line out • 2 x 3W speakers • Windows 11 Pro • 711 x 232 x 514mm (WDH) • 1yr limited RTB warranty • part code MS-AF83 • power: 40W idle, 103W peak

Dell 32 Plus 4K Monitor (S3225QS)

No USB-C, but this stylish monitor wins for its 120Hz refresh rates, excellent speakers and image quality

SCORE ★★★★½

PRICE £308 (£369 inc VAT)
from dell.com

As can be seen from the Dell UltraSharp review opposite, Dell's rollout of its Good, Better, Best strategy – Dell, Dell Plus, Dell Premium – remains a work in progress. Here, though, we have the first example of its mid-tier Plus range coming to monitors, and rather nice it is too.

In terms of looks, it feels more like a Premium product. I bring your attention to the incredibly slim bezels, while to my eyes the white finish is classier than the over-used metallic grey seen on the UltraSharp range. You still enjoy height-adjustment, up to 100mm, while the tilt angle of -5° to 21° is absolutely fine. What you don't get is any rotation: if you want to show your screen to your neighbour, you're moving the whole unit.

One giveaway that this may not be the world's most expensive monitor comes when you activate the on-screen display (OSD). There simply aren't that many things to do. You have the normal selection of presets, ranging from movie to first-person-shooter, but in terms of shifting gamuts there's only the standard option, a customisable setting and sRGB.

Dell has sensibly opted for a joystick to control the OSD, and it's pleasingly responsive: some monitor joysticks have a fudgy, indistinct action like a gaming joystick from the 1980s, but this one moves decisively with no misfires.

That's genuinely useful here as the OSD offers neat customisation offerings. If you're constantly fiddling with the brightness, inputs and audio volume, for instance, then you can choose for these three settings to be accessible via shortcuts – assign them to up, right or down on the joystick.

ABOVE **Stylish looks, slim bezels and decent image quality make this 32in display a hit**

What's more, you can control all these settings via Dell's excellent Display and Peripheral Manager, which works over HDMI – no need for a USB connection, which is a good thing as there's no USB hub or USB-B downstream port.

Nor can you connect over USB-C: one DisplayPort and two HDMI inputs are your lot. I like the fact that one of the HDMI ports is tucked away behind a removable panel, which means you can tuck it out of sight with neat cabling. It's only a shame the same detail isn't offered for the power cable or the other two video inputs, but a sensibly positioned cable tidy at the rear of the stand means you can hide it away with little effort.

Then we come to the most important aspect of any monitor: image quality. This is a 10-bit VA panel, so it has no shortage of colours (1.07 billion) and also offers excellent contrast and naturally quick response rates. Here, Dell claims 4ms grey-to-grey if you activate overdrive – switching to the first-person-shooter profile will do this automatically – and more importantly for most people it can refresh at up to 120Hz. That's fine for all but the most competitive gamers.

It performed well in our technical tests, covering 83% of the DCI-P3 gamut with an average Delta E of 0.67. That peaked at 3.02, so colour accuracy is average compared to the very best monitors, but this monitor will still be a respectable choice for photographers. If you prefer your whites sparkling then take a look at the sRGB mode, as this edges closer to the ideal 6500K colour temperature (I measured 6479K), improves colour accuracy and locks on almost perfectly (96% coverage, 97% volume) to the sRGB gamut.

With a flat 32in panel there's always a certain amount of colour shift as you look at different areas, and so it is here. Measuring also revealed a drop-off in brightness by between 5% and 10% at the edges, but in everyday use I didn't notice it.

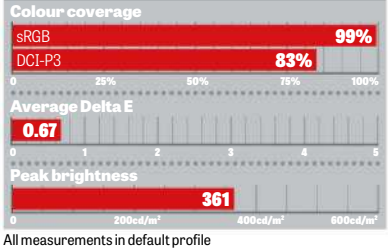
There's one final feature I must mention: the speakers. These are shockingly good for a mid-range monitor, to the point where I listened to music on the Dell throughout the working day. They also push up to a surprisingly high volume, easily enough to fill a typically sized study. There's also support for HDR content, but it only makes a minor difference. Still, with booming soundtracks and plenty of colour, I enjoyed watching Netflix on this monitor.

"The speakers are shockingly good for a mid-range monitor, to the point where I listened to music on the Dell throughout the working day"

It may not have the whizz-bang features of the Dell UltraSharp opposite, but in the end the only thing I missed was a USB-C port. This means it compares poorly against the Iiyama ProLite XUB3293UHSN-B5 for value: this costs £378 from **ballicom.co.uk** but includes a USB-C port and two-port USB dock. Still, if you prioritise 120Hz refresh rates (the Iiyama is stuck at 60Hz), audio quality and looks over USB-C connectivity then the Dell is a great choice. **TIM DANTON**

BELOW **There are lots of adjustment options in the stand, but it can't be rotated**

MAIN TEST RESULTS



All measurements in default profile

SPECIFICATIONS

31.5in 3,840 x 2,160 VA panel • up to 120Hz refresh rate • 10-bit panel (1.07 billion colours) • HDR10 • 4ms grey-to-grey response time • 2 x HDMI 2.1 • DisplayPort 1.4 • 2 x 5W speakers • 100mm height adjustment • -1° to 21° tilt • 713 x 222 x 446-546mm (WDH) • 8.8kg • 3yr advanced exchange warranty • 27W power at 200cd/m²

Dell UltraSharp 32 4K Thunderbolt Hub Monitor (U3225QE)

Gorgeous, high quality and supremely well connected, which very nearly justifies that price

SCORE ★★★★½

PRICE £790 (£948 inc VAT)
from dell.com

There are several things about Dell's latest UltraSharp monitor that make it special. One is that it uses an IPS Black panel, promising far deeper blacks than normal IPS panels; another its ludicrous levels of connectivity, built around Thunderbolt 4; and the third is that it escapes Dell's new branding of Dell, Dell Plus, Dell Premium to indicate good, better, best. Perhaps it's so spectacularly good that even the word "Premium" can't contain it?

Weight is given to this argument by the most striking IPS panel I've seen on a desktop monitor. If you're upgrading from a five-year-old IPS display then the colours will slap you in the face, and due to its rich contrast (2,550:1 in our tests) and huge colour gamut this is a natural choice for entertainment. With the crisp whites you'd expect from IPS technology and DisplayHDR 600 certification, it's a great choice for those who need to mix work with viewing pleasure. Although oddly it doesn't include any speakers.

Dell offers a fine choice of presets, with options of DCI-P3, Display P3 and sRGB. All do an excellent job of locking to the claimed colour spaces, so if you need to be confident that the colours you see are accurate then it's a better choice than, say, the Dell monitor opposite.

To quell expectations, the UltraSharp doesn't have professional features that HDR video editors and print designers might seek. The former may want support for Hybrid Log Gamma (HLG), the latter Pantone certification, both of which add to a monitor's price – and Dell no doubt felt this was high enough already.

What you do get is an exceptional range of ports. The king is the 140W Thunderbolt 4 upstream port, and frankly if you're not going to use this then you're wasting your money. The key feature is support for daisy-chaining a second monitor. You can do so using the second Thunderbolt 4 port or via the DisplayPort output, and if you have a matching Dell monitor you can even synchronise their settings.

Dell is equally generous when it comes to other ports. Round the back, you'll find video inputs for HDMI and DisplayPort, plus a 2.5GbE connector, four USB-A 3.2 Gen 2 ports, a 3.5mm line out and a USB-C upstream port (you'll need this if you want to use the KVM to share a keyboard and mouse between a second monitor). But then there's a handy hidden extra: press on the bottom left of the bezel and a pop-down box appears that contains two more USB-C ports and a USB-A port. Fantastic for quickly connecting external storage or a webcam, and all ports are rated at 10Gbits/sec.

There's yet more versatility built into the stand, which even pivots. Comparing it to the Dell Plus opposite is like an exercise in one-upmanship, with greater height adjustment (150mm versus 100mm), more tilt and the ability to swivel, albeit only by 30° in each direction.

It even boasts a slicker OSD, again operated by a joystick, and numerous options. For example, you can tell it to automatically adjust brightness and temperature depending on ambient levels; there's a wide variety of picture-in-picture and picture-by-picture modes; and it gives you access to a diagnostic mode and the pre-calibration reports.

I hoped for a better warranty, with the three-year, advanced exchange on offer here typical of far cheaper monitors. When investing this much, I resent paying Dell another £206 for its higher level of ProSupport and an extension to five years. At least it meets the tougher EPEAT Climate+ criteria, so there are signs that Dell is going in the right direction in terms of sustainability.

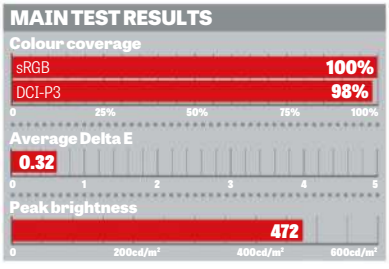
This is an excellent screen, but I'm left wondering who should buy it. I think the answer boils down to whether you want a dual 4K display setup (so long as your second screen includes a DisplayPort, it will work daisy-chained). Even if you're unsure about that, this is an excellent debut for IPS Black panels, with a richness of colour and contrast (I measured it at 2,550:1) that goes well beyond most IPS displays. If you have the budget, you won't regret lavishing it on this display. **TIM DANTON**

ABOVE Rich blacks lend extra impact to games, photos and videos

LEFT This hidden box makes it easy to connect external drives and gizmos

"This is an excellent debut for IPS Black panels, with a richness of colour and contrast that goes well beyond most IPS displays"

BELOW A flexible stand means you can pivot the screen and adjust it by up to 150mm in height



All measurements in default profile

SPECIFICATIONS

31.5in 3,840 x 2,160 IPS panel • up to 120Hz refresh rate • 10-bit panel (1.07 billion colours) • VESA DisplayHDR 600 • 5ms grey-to-grey response time • Thunderbolt 4 upstream (140W) • Thunderbolt 4 downstream (15W) • HDMI 2.1 • DisplayPort 1.4 in • DisplayPort 1.4 out • 2.5GbE port • USB-C 3.2 Gen 2 upstream • 2 x USB-C 3.2 Gen 2 downstream • 5 x USB-A 3.2 Gen 2 • 3.5mm line out • 50mm height adjustment • pivot • –30° to 30° tilt • –5° to 21° tilt • 713 x 215 x 469-619mm (WDH) • 9.3kg • 3yr advanced exchange warranty • 27W power at 200cd/m²

Nvidia GeForce RTX 5060 Ti 16GB

Delivering 15% more performance than its predecessor, this is a solid choice for 1440p gaming

SCORE ★★★★½

PRICE From £339 (£399 inc VAT) **from scan.co.uk**

When Nvidia launched the 16GB model of the RTX 4060 Ti, it played second fiddle to the mainstream 8GB version. This time around, the roles have swapped, with Nvidia pushing the 16GB version of the RTX 5060 Ti and the 8GB model being far less common.

And for good reason. Most games are still able to run okay on 8GB cards at 1080p with maxed-out settings, and often even 1440p. But 4K proved to be too much in several games in our test suite, so if you're spending this much on a card – the cheapest version of the RTX 5060 Ti costs around £350 – then it makes sense to choose 16GB.

One of the biggest changes with the RTX 50-series (Blackwell) is support for GDDR7 memory. The 4060 Ti was stuck with vanilla GDDR6 memory running at 18Gbits/sec, while the 5060 Ti is boosted to 28Gbits/sec, giving a potential 56% increase in total memory bandwidth.

Nvidia doesn't make Founders Edition versions of the 5060 Ti, but Asus sent its RTX 5060 Ti 16GB Prime OC (£500 inc VAT from **nvidia.com**). It comes with a minor factory overclock of 2,617MHz, and if you install Asus' GPU Tweak III software and enable the OC mode you get another 30MHz. But I didn't use this, as that's a 1.1% boost, which is within the margin of error for many of our tests.

With a triple-fan design, the Prime OC isn't particularly small but still qualifies for Nvidia's "SFF Ready" requirements. It weighs 901g and measures 304 x 120 x 50mm, so a 2.5-slot thickness for a 180W TGP (total graphics power) card. You could say it's overkill, but it means there's less noise from the fans. It comes with a single 8-pin connector, which proved enough: the maximum power draw I recorded for the card was 205W.

As with most modern cards, you get three DisplayPort 2.1b ports and one HDMI 2.1b port. Nvidia's Blackwell GPUs support the full 80Gbits/sec maximum that DisplayPort 2.1 allows for, also called UHBR20 (Ultra High Bit Rate 20). The HDMI port only offers 48Gbits/sec by comparison, though both are capable of driving a 4K 240Hz monitor with DSC (Display Stream Compression) enabled.

The graphs below reveal the key message in terms of performance – all tests are run without DLSS and the toughest settings – but the most results are for 1080p Ultra and 1440p Ultra. These serve well as proxies for 4K with performance mode and quality mode upscaling respectively.

ABOVE We tested an Asus variant of the card, but there are many to choose from

Comparing it to the 8GB 4060 Ti, the 5060 Ti 16GB card is only 15 to 17% faster than the 4060 Ti at 1080p, but the margin increases to 27% at 1440p and then a massive 69% at 4K.

With ray tracing, the RTX 5060 Ti 16GB comes in ahead of AMD's previous generation RX 7800 XT, but it's still behind the RTX 4070. The 5070, 9070 and 4070 Super are all tied in overall RT performance. Gen-on-gen, the 5060 Ti 16GB outperforms the RTX 4060 Ti 16GB by 13 to 19%, with the bigger margins coming at higher resolutions and settings.

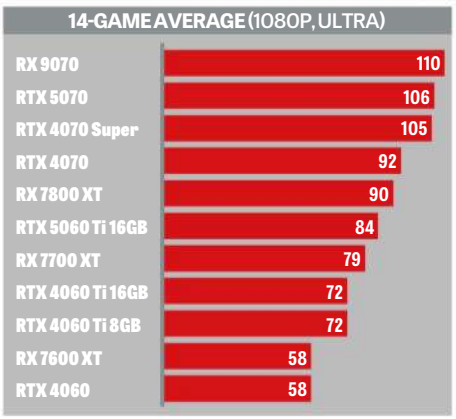
"The 5060 Ti 16GB isn't a massive generational improvement in terms of raw gaming performance, but it is an improvement"

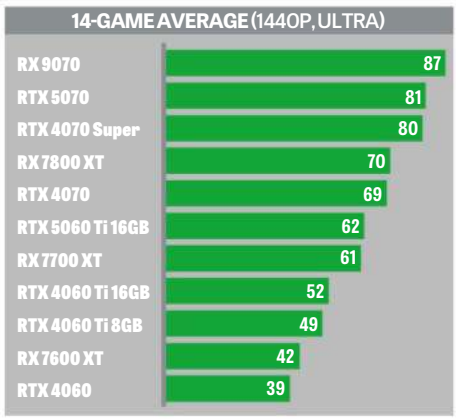
All told, the 5060 Ti 16GB isn't a massive generational improvement in terms of raw gaming performance, but it is an improvement. Add the extras that stem from the Blackwell, including neural rendering, DLSS 4 and Multi Frame Generation, and this looks like a solid choice for gamers with £400 to spend. **JARRED WALTON**

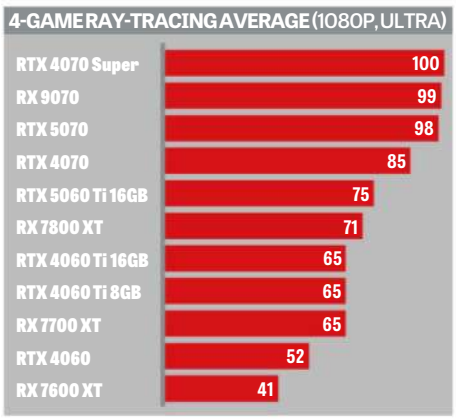
BELOW The Asus variant on test takes up 2.5 slots but it's also quiet

SPECIFICATIONS

PCIe Gen 5 x8 graphics card • 2,572MHz boost clock • 16GB GDDR7 memory • 128-bit memory interface width • 448GB/sec memory bandwidth • 36 streaming multiprocessors • 4,608 GPU shaders • 144 tensor/AI cores • 36 ray tracing cores • 48 render output units • 144 texture-mapping units • 180W TGP







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pro-series

mid [PRO1]

£449.99

CPU	AMD RYZEN 5 8500G
Core	6 Cores - 12 Threads
Clock	(3.5/5Ghz Turbo)
Mob	ASUS TUF A620M-PLUS WIFI
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	AMD RADEON Graphics
Case	KOLINK Observatory HF MESH
O/S	*NO OPERATING SYSTEM*
PSU	BUILDER 500W PSU

Max [PRO2]

£979.99

CPU	AMD RYZEN 5 7600X
Core	6 Cores - 12 Threads
Clock	(4.7/5.3Ghz Turbo)
Mob	ASUS PRIME B650M-A WIFI II
RAM	ADATA 32GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	1stPlayer D3-A aRGB - Black
O/S	*NO OPERATING SYSTEM*
PSU	CIT 700W PSU

UBER [PRO3]

£1159.99

CPU	INTEL Core i5 14600K
Core	14 Cores - 20 Threads
Clock	(2.6/5.3Ghz Turbo)
Mob	ASUS B760M-K
RAM	ADATA 32GB DDR5 5600Mhz
M.2	ADATA 2TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4060 TI 16GB
Case	GAMEMAX F15M MESH
O/S	*NO OPERATING SYSTEM*
PSU	BEQUIET 850W Gold PSU

Aurora RANGE

i3 Aurora [AUR1]

£629.99

CPU	INTEL Core i3 14100F
Core	4 Cores - 8 Threads
Clock	(3.5/4.7GHz)
Mob	ASUS B760M-K
RAM	ADATA 16GB DDR5 5600Mhz
M.2	TRANSCEND 1TB M.2 nVME
GPU	NVIDIA RTX3050 8GB
Case	GAMEMAX Abyss Mini RGB
O/S	MICROSOFT Windows 10/11
PSU	CIT 600W Bronze PSU

i5 Aurora [AUR2]

£999.99

CPU	INTEL i5 14400F
Core	10 Cores - 16 Threads
Clock	(Turbo 4.7Ghz)
Mob	ASUS B760M-K
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 2TB M.2 NVMe
GPU	NVIDIA RTX4060 8GB
Case	CORSAIR iCUE 4000X
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W PSU

i7 Aurora [AUR3]

£1599.99

CPU	INTEL Core i7 14700KF
Core	20 Cores - 28 Threads
Clock	(3.4/5.6Ghz Turbo)
Mob	ASUS PRIME Z790-P WIFI - DDR5
RAM	CORSAIR 32GB DDR5 6000Mhz
M.2	ADATA 1TB S70 Blade M.2 nVME
GPU	NVIDIA RTX4070 12GB
Case	CORSAIR iCUE 4000X RGB
O/S	MICROSOFT Windows 10/11
PSU	CORSAIR 650W Gold PSU

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Netgear Nighthawk RS100

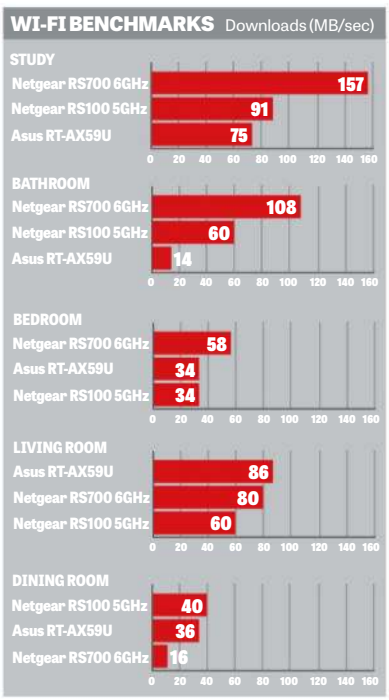
Don't be put off by the low price – this budget Wi-Fi 7 router delivers a decent helping of speed and range

SCORE ★★★★☆

Price £108 (£130 inc VAT)
from amazon.co.uk

In the past 18 months we've seen a succession of Wi-Fi 7 routers from Netgear. First came the top-tier Nighthawk RS700S (*see issue 353, p76*), with a steep launch price of £800; sensing that this might be beyond the budget of most upgraders, the company followed up with more affordable RS300 and RS200 models, costing (neatly enough) £300 and £200 respectively. The latest arrival is the cheapest model yet, and though Netgear hasn't quite got the price down to a round ton, at £130 it's still aggressively inexpensive.

As you'd expect, the hardware you get for that money is decidedly cut down compared to the premium model. Where the RS700 boasts a top speed of 11.5Gbits/sec on its 6GHz radio, the RS100... well, actually it doesn't have a 6GHz radio at all. For this budget router, Netgear has stuck with a classic dual-band design, with 2x2 MIMO and a top speed of 2.9Gbits/sec on the 5GHz band – considerably slower than many Wi-Fi 6 routers we've tested.



That's not the only compromise. The RS100 doesn't support the fat 320MHz channel width that was introduced with Wi-Fi 7, nor does it implement the new multilink operation mode, so you can't aggregate the 2.4GHz and 5GHz radios into one high-bandwidth, high-resilience connection.

But dwelling on what it doesn't do sells this little router short. Though diminutive in stature – it stands just 184mm tall – it packs in two technologies that make a big difference to performance. One is Wi-Fi 7's new 4K-QAM encoding system, which increases wireless data throughput by 20% compared to previous standards; the other is a feature called "preamble puncturing", which allows the router to skip over any frequencies where it detects interference, without affecting the rest of the data channel.

The result is a router that's able to make highly efficient use of the airwaves – a benefit that was visible in my performance tests. As always, I performed these by setting the router up in the study of my own home, connecting to it from a router equipped with an Intel BE200 Wi-Fi 7 network card, and copying files to and from a NAS appliance connected to the router via Ethernet.

As you can see from the graph on the left, the Nighthawk RS100 doesn't get near the maximum download speeds of the top-end RS700S, and that's hardly a surprise. It also lagged behind the RS200 and RS300 on both the 5GHz and 6GHz bands. At the same time, overall performance was a step up from your average Wi-Fi 6 router – compare, for example, the Asus RT-AX59U, a long-time fixture on our A-List.

ABOVE The four LAN ports are all limited to 1GbE, but speeds from this router are still fine

Indeed, I found the RS100 more than fast enough for anything I wanted to do, even when connecting from a few rooms away. With an average download speed of 57MB/sec, it's an order of magnitude faster than what you need for streaming and video calls, with enough bandwidth and coverage to give me the full benefit of a 250Mbits/sec broadband line anywhere in my home (Netgear claims it will cover an area of up to 185 square metres).

All of this might make you wonder whether there's any reason to pay more for a Wi-FI 7 router. However, if you care about the speed of your internal LAN – for example, if you regularly exchange large files with a NAS appliance – then a more expensive router could give you a smoother ride, with both faster Wi-Fi connections and multi-gigabit Ethernet. While the Nighthawk RS100 does have a 2.5Gbits/sec Ethernet port, this is only for the incoming internet line; the four LAN ports are all limited to gigabit speeds. There's no USB connection for sharing an external drive over the network, either.

Another consideration might be firmware features. The RS100 is very easy to set up using the Nighthawk mobile app, and I'm always a fan of Netgear's analytics tools, which let you use your phone to check signal strength and scan for interfering networks in different parts of your home. But while the main management interface looks the same as the one on Netgear's high-end routers, the usual inbound VPN server and parental control features are missing. The Armor network security service is available, but only as a 30-day trial, after which it costs a steep £85 per year to keep it going.

"For most of us, this router covers all the important bases, for a price that's very hard to argue with"

BELOW The RS100 has a classic dual-band design and stands just 184mm tall

In short, if you're the sort of power user who's peering over the spec sheet and saying "this won't do for me" then you're probably right. For most of us, though, this router covers all the important bases, for a price that's very hard to argue with. Sure, there are plenty of cheaper Wi-Fi 6 models, but that's starting to feel like yesterday's technology; the RS100 gives you a very viable Wi-Fi 7 service, without making you pay for high-end features and performance you don't really need. **DARIEN GRAHAM-SMITH**

SPECIFICATIONS

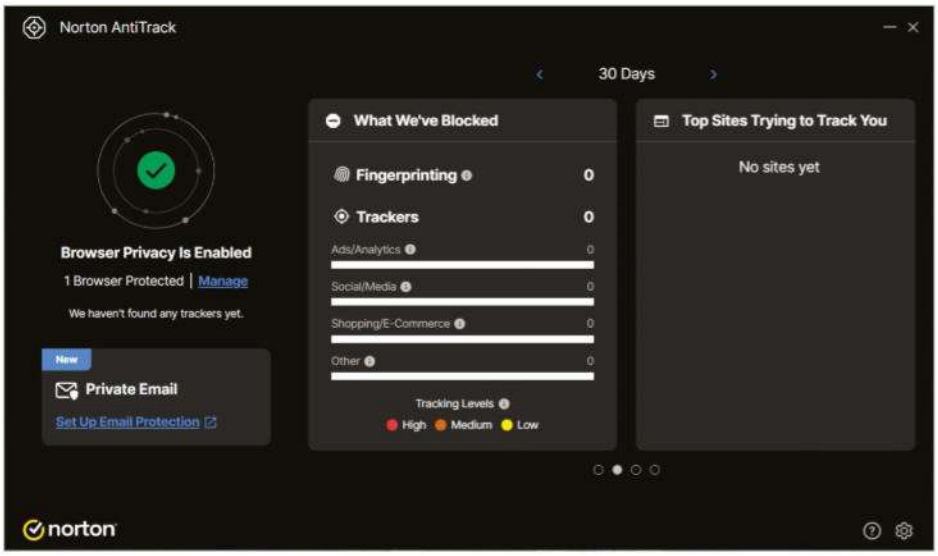
Dual-band 2.4GHz/5GHz/6GHz router • 4 streams • 2.5GbE WAN, 4 x GbE LAN • 2GHz quad-core processor • 66 x 122 x 184mm (WDH) • 2yr limited warranty

Your bonus software

Total value this month £120

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

Norton AntiTrack 2025



One-device, one-year licence worth £40
norton.com
REQUIRES Windows 10, Android 8, iOS 15.2 or later versions; online registration

As soon as you connect to the internet – and the whole time you spend browsing – you're leaving behind a trail of digital footprints. The websites you visit may well be collecting information about you and your browsing habits, and adverts displayed on those sites could be doing the same thing.

There are social media elements to consider, too, with many networks able to see where you go courtesy of tracking pixels and other hidden technologies. All of this tracking is considered a huge invasion of privacy by some people, not to mention a security risk.

The solution? Norton AntiTrack protection. As its name suggests, AntiTrack prevents the sites you visit from monitoring your online activity, using a variety of techniques to block tracking, fingerprinting and profiling. It offers native browser extensions for Chrome, Firefox and Microsoft Edge, which help you keep an eye on how many components have been automatically blocked and who was responsible for the tracking attempts.

You may be surprised at just how many privacy-invading elements there are on the sites you visit.

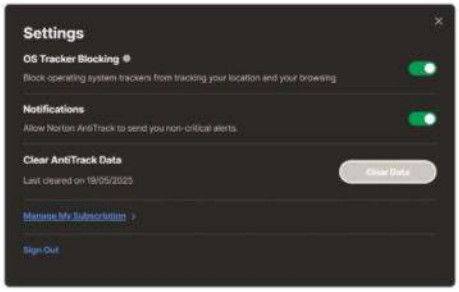
By limiting the amount of personal data you share, AntiTrack can limit the number of targeted ads that you see, prevent third parties from collecting and sharing your online activity, help keep your email address private (on Windows only), and let you browse like no-one's watching.

Note that some tracking components are essential for certain sites to function properly. For example, if you were to block all tracking, you might find that some shopping sites didn't work as you would expect, as they wouldn't be able to remember your choices and preferences. As such, Norton AntiTrack includes a handy "Fix It" option that you can invoke when a situation like this arises.

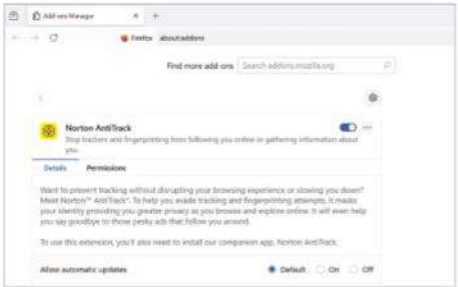
This doesn't disable Norton's core AntiTrack protection (which is another option), but instead masks your personal data. This means that even though the site in question is able to store data about your visit and operate the way it should, your actual identity is concealed.

This is a neat solution that works smoothly – and, importantly, doesn't interfere with your day-to-day use of the internet, like so many other privacy tools do. It works invisibly in the background, to the extent that you could soon start to forget you even have it installed.

ABOVE Norton AntiTrack keeps an eye on the sites you visit and logs all the various tracking technologies it has blocked



ABOVE You can choose to block trackers built into your operating system, as well as ones embedded into web pages and online apps



ABOVE Extensions for all the most popular browsers provide native tracker-blocking and easy configuration

Photo Card 3

- Transform your photos into stunning greetings cards, complete with your own text and captions
- No artistic or design skills required – choose from 50 professionally designed templates
- Create cards for all types of occasion, from birthdays and Christmas to engagements, holidays and more

Full product worth £15 ashampoo.com
REQUIRES Windows 7 or later; 50MB drive space; in-application registration

Win11PrivacyFix2025

- Block Windows 11's controversial data-sharing features with a single click
- Prevent all communication with Microsoft, or choose how to balance privacy, security and functionality
- You can also change how Windows 11 looks and feels, and restore the Windows 10-style Start menu

Full product worth £10 abelssoft.de
REQUIRES Windows 11 or later; 10MB drive space; in-application registration

Audials Music 2025.1 SE

SE product worth £20 audials.com
REQUIRES Windows 8 or later; 250MB drive space; in-application registration

- Find your favourite tracks online, stream them and optionally download them to your PC
- Works with popular streaming services, plus tracks already stored on your computer
- Add songs and videos to custom collections

Malware Fighter 12 Pro

Six-month licence worth £10 iobit.com
REQUIRES Windows 7 or later; 70MB drive space; online registration

- Straightforward anti-spyware tool with scheduled scans, USB protection and more
- Run on-demand scans for threats that your existing anti-malware tool might have missed
- Monitor startup items with real-time protection

WebSite X5 Go 2025

Full product worth £25 websitex5.com
REQUIRES Windows 10 or later; 300MB drive space; online registration

- A powerful tool that makes it easy to develop top-quality responsive websites
- No design or coding experience necessary, with more than 25 professional templates
- Drag and drop page elements to build your site

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GAMING & CREATIVE LAPTOPS

With Nvidia's RTX 50-series now coming to laptops en masse, we put seven top contenders through their paces

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We've already had a trickle of laptops based on Nvidia's new RTX 50 series of mobile graphics, starting with our review of the Razer Blade 16 (*see issue 369, p58*) last month. Now that trickle is a flood. Our aim here is to round up a collection of the best gaming laptops that have landed so far, to help you decide which is best for you and also to show the state of the market.

Our benchmarks inevitably focus on games, but one of the reasons we're keen to cover these laptops in depth is that they lead a convincing double life as creative laptops. It's ludicrously easy to switch between Nvidia's Game Ready drivers and its Studio drivers, with the latter guaranteed to work with creative apps from Adobe, Blackmagic, 3ds and many more.

There's another side to these laptops, too: they're a brilliant choice for running local AI apps. That could be image creation and editing, but we're very much at the beginning of LLMs (and small language models) on our systems.

So even if you're not in the market for a gaming laptop, we hope that you find this round-up interesting.

CONTRIBUTORS Jason England, Andrew E Freedman, Brandon Hill, Madeline Ricchiuto, Rami Tabari, Alex Wawro

		RECOMMENDED	RECOMMENDED			RECOMMENDED	
	Asus ROG Strix Scar 16 (2025)	Asus ROG Strix Scar 18 (2025)	Asus ROG Zephyrus G14 (2025)	Gigabyte Aorus Master 16 (2025)	HP Omen Max 16 (2025)	Lenovo Legion Pro 7i Gen 10	MSI Raider 18 HX AI A2XW
Overall rating	★★★★½	★★★★½	★★★★★	★★★★½	★★★½☆	★★★★★	★★★★½
Purchase information							
Price[1]	£3,166 (£3,800 inc VAT)	£3,917 (£4,700 inc VAT)	£2,667 (£3,200 inc VAT)	£2,417 (£2,900 inc VAT)	£3,333 (£3,999 inc VAT)	£2,700 (£3,240 inc VAT)	£3,7500 (£4,200 inc VAT)
Supplier	amazon.co.uk	asus.com	asus.com	scan.co.uk	hp.com	lenovo.com	scan.co.uk
Model number	G635LW-RW041W	G835LX-SA009W	GA403WW-QS075W	BYHC5UKE65SP	BG9D5EA#ABU	83F5CTO1WWGB1 (1TB)	A2XWIG-011UK
Dimensions (WDH)	354 x 268 x 22.8-30.8mm	399 x 298 x 23.5-32mm	311 x 220 x 15.9-18.3mm	357 x 254 x 23-29.9mm	357 x 269 x 22.9-24.8mm	364 x 276 x 21.9-26.6mm	404 x 308 x 24-32.1mm
Weight	2.8kg	3.3kg	1.6kg	2.5kg	2.7kg	2.7kg	3.6kg
Warranty[2]	2yr RTB	2yr RTB	2yr RTB	2yr RTB	1yr RTB	1yr C&R	2yr RTB
Core components							
Processor	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	AMD Ryzen AI 9 HX 370	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	Intel Core Ultra 9 285HX
Cores	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	12	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)
Graphics	16GB Nvidia GeForce RTX 5080	24GB Nvidia GeForce RTX 5090	16GB Nvidia GeForce RTX 5080	16GB Nvidia GeForce RTX 5080	24GB Nvidia GeForce RTX 5090	16GB Nvidia GeForce RTX 5080	16GB Nvidia GeForce RTX 5080
Boost wattage	175W	175W	110W	175W	Not stated	175W	175W
RAM	32GB DDR5-5600	64GB DDR5-5600 (tested with 32GB)	32GB LPDDR5X-8000	32GB DDR5-5600	64GB DDR5-5600 (tested with 32GB)	32GB DDR5-6400	32GB DDR5-6400
Storage	1 x 2TB	2 x 1TB (RAID0)	2TB	1 x 2TB	2TB	2TB (1 free)	2 x 2TB
Display							
Size	16in	18in	14in	16in	16in	16in	18in
Technology	Mini-LED	Mini-LED	OLED	OLED	OLED	OLED	Mini-LED
Resolution	2,560 x 1,600	2,560 x 1,600	2,880 x 1,800	2,560 x 1,600	2,560 x 1,600	2,560 x 1,600	3,840 x 2,400
Frequency	240Hz	240Hz	120Hz	240Hz	240Hz	240Hz	120Hz
Battery & charger							
Battery capacity	90Wh	90Wh	73Wh	99Wh	83Wh	99Wh	99.9Wh
Charger wattage	380W	380W	200W	330W	330W	400W	400W
USB-C charging?	✓ (120W)	✓ (120W)	✗	✓ (PD 3.0)	✓ (wattage not stated)	✓ (140W)	✗
Ports & connectivity							
Wireless standard	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7
Bluetooth	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4
HDMI	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1
USB-C	2 x Thunderbolt 5	2 x Thunderbolt 5	1 x USB 4, 1 x USB 3.2 Gen 1	1 x Thunderbolt 5, 1 x Thunderbolt 4	2 x Thunderbolt 4	1 x Thunderbolt 4, 1 x USB 3.2 Gen 2	2 x Thunderbolt 5
USB-A	3 x USB 3.2 Gen 2	3 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	1 x USB 3.2 Gen 2, 2 x USB 3.2 Gen 1	3 x USB 3.2 Gen 2
LAN	2.5GbE	2.5GbE	✗	1GbE	2.5GbE	2.5GbE	2.5GbE
SD card reader	✗	✗	✓	✓ (microSD)	✗	✗	✓ (SD Express)
3.5mm audio jack	✓	✓	✓	✓	✓	✓	✓
Webcam	1080p IR	1080p IR	1080p IR	1080p IR	1080p IR	5MP IR	1080p IR
Other features							
RGB	Aura Sync Light Bar, Aura Sync logo, AniMe Vision	Aura Sync Light Bar, Aura Sync logo, AniMe Vision	Slash Lighting	Front light bar, rear strip	Front light bar	✗	Front light bar
Supplied OS	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home

1 Price is correct at time of going to press. 2 Warranty is for mainland UK only

Asus ROG Strix Scar 16 (2025)

With flashy lights and strong performance, the ROG Strix Scar 16 is only let down by its relatively high cost

SCORE ★★★★½

PRICE £3,166 (£3,800 inc VAT) from amazon.co.uk

Asus' ROG Strix Scar 16 makes quite a visual statement. For a start, the large ROG logo on the lid is actually a multicolour LED. Even that is made to look bashful compared to the array of 810 white LEDs that dance around when the laptop is in standby mode and flash "STRIX" when you turn it on. You can change these patterns to premade animations or import your own.

Want more? There's an RGB light ring around the entire perimeter of the enclosure, and per-key backlighting on the keyboard – all of which can be configured with the supplied Armoury Crate tool.

Despite the showy exterior, the construction feels basic in places. It's solid, but the keyboard deck and chassis bottom are constructed of plastic (this helps to prevent overheating and cuts down on weight), while the bezels at the top and bottom of the screen are sizeable.

Still, there's a good set of ports around the edges. Asus incorporates three USB-A ports and twin Thunderbolt 5 connectors, along with an HDMI 2.1 port and a 3.5mm headphone jack. There's also a 2.5GbE port, plus Wi-Fi 7.

The screen is a 16in, 2,560 x 1,600 number, with a refresh rate of 240Hz. The standout feature is mini-LED backlighting, which puts this laptop far above its peers in brightness: I measured 457cd/m² with SDR content, while peak levels exceeded 1,200cd/m² when viewing HDR content. Colours are rich and vibrant, with the panel covering 81% of the DCI-P3 colour space and 115% of the sRGB space.

Inside, the expected Core Ultra 9 275HX processor – featuring eight performance cores and 16 efficiency cores – is matched here with a GeForce RTX 5080 GPU and 32GB of DDR5-5600 memory. You can buy an RTX 5090 version with 64GB of RAM for £4,600 direct from Asus.

This version is plenty for most gamers, though. I tried out various titles but spent most of my time running and gunning in *Indiana Jones and the Great Circle*. It's a visual masterpiece and the Strix Scar 16 has the hardware to do it justice: with the resolution set to 1440p and the detail setting cranked to "Ultra," the game ran smoothly at between 70fps and 100fps, with high-quality textures and realistic reflections.

Aside from big screens, larger gaming laptops usually benefit from spacious keyboards. Asus has fitted the ROG Strix Scar 16 with a pleasing full-size keyboard, offering 2mm of key travel. Five keys at the top of the keyboard deck default to controlling the volume, microphone and power mode, although you can reprogram these using Armoury Crate.

Below, you'll find a large glass trackpad, which is smooth and has a satisfying click. It also supports Asus' quirky NumberPad feature, which turns the touchpad into a touch-sensitive numeric keypad when you hit the Num Lock key. It's not ideal for lengthy data-entry tasks, but it works well for shorter jobs and means the main keyboard doesn't get shunted to the side.

Audio from the ROG Strix Scar 16's four built-in speakers is strong, with plenty of volume and adequate bass. They certainly helped bring *Indiana Jones and the Great Circle* alive, from the whip cracks to Indy's feverish punches and the grunts he makes when he jumps from ledges. The speakers do, however, have to compete with audible fan noise when you're gaming; I still preferred to use a headset.

ABOVE **Light appeal: the eye-catching ROG Strix Scar 16 is a strong performer**

"While the ROG Strix Scar 16 comes with a decent amount of memory and storage, it's delightfully easy to upgrade"

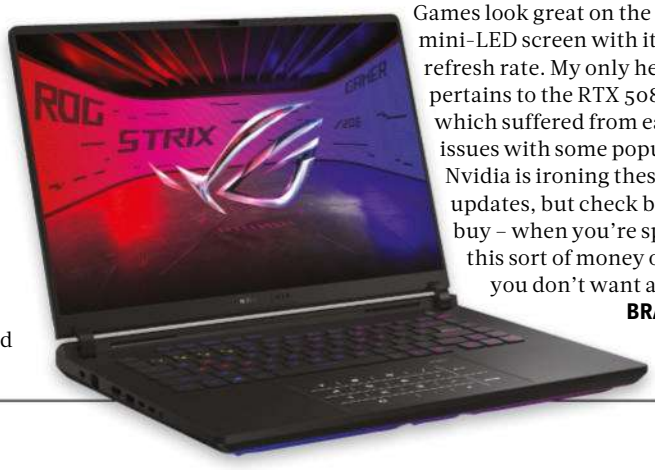
While the ROG Strix Scar 16 comes with a decent amount of memory and storage, it's delightfully easy to upgrade. You don't need a screwdriver at all: flip the laptop over and you'll see a small latch at the front of the chassis with an arrow on it. Push this forward and you can slide the whole bottom casing off, exposing the interior and granting direct access to the system's twin SODIMM sockets – our review unit had both occupied with 16GB DDR5-5600 modules – and two M.2 slots. One of these was taken by a 2TB Western Digital PCIe 4 SSD, but the board also supports PCIe 5 drives if you want to add the fastest available storage.

As for battery life, you're never going to get hours and hours of gaming from a laptop like this, but in our desktop endurance benchmark – which browses the web, streams videos and runs light OpenGL tests – it lasted 6hrs 30mins. That's respectable for a gaming laptop.

In all the ROG Strix Scar 16 is a strong choice, with an eye-catching design, plenty of connectivity and a fast SSD that can be extended or replaced with an even faster one. Games look great on the large mini-LED screen with its excellent refresh rate. My only hesitation pertains to the RTX 5080 graphics, which suffered from early driver issues with some popular games. Nvidia is ironing these out with updates, but check before you buy – when you're spending this sort of money on a laptop, you don't want any glitches.

BRANDON HILL

BELOW **The mini-LED panel's backlighting puts this laptop above its peers in brightness**



Asus ROG Strix Scar 18 (2025)

The most powerful gaming laptop around – a fact that's amply reflected in its bulk and that whopping price

SCORE ★★★★☆

PRICE £3,917 (£4,700 inc VAT)
from asus.com

If you thought the ROG Strix Scar 16 was a beast, you'll baulk at this huge gaming laptop. It has an 18in display that looks more like a desktop monitor than a laptop screen, and it weighs a hefty 3.3kg.

While the ROG Strix Scar 18 isn't the most portable gaming system around, it is one of the best. That's thanks to a combination of top-tier components and a screen that's not only huge but gorgeous.

When I say top-tier components, I mean the aspirational combination of an Intel Core Ultra 9 275HX CPU and Nvidia RTX 5090 GPU. It's a power pairing made in gaming heaven, enabling the latest AAA titles to run smoothly with incredible visuals. In fact, Asus squeezes notably more performance out of the duo than other laptops in this class: in the *Cyberpunk 2077* benchmark, the Strix Scar 18 proved around 14% faster than the HP Omen Max 16, even though both machines have the same CPU and GPU combination.

That's before we talk about Nvidia's DLSS 4 technology, which uses AI to boost frame rates with little impact on the overall experience. Turning it on, I saw frame rates in *Cyberpunk 2077* leap to an insane average of 232fps at the maximum quality settings and 1080p.

Rounding it all off is the stunning display, with a sharp resolution and a 16:10 aspect ratio – great for games and productivity alike. It supports a 240Hz refresh rate for impeccably smooth motion, allowing you to get the full benefit of those high frame rates. The use of mini-LED backlighting means you don't quite get the perfect contrast of an OLED panel, but the Strix Scar 18 makes up for that with superb brightness. And if you choose to turn this immensely capable laptop to creative projects, Pantone validation means you can have total confidence in its accurate, professional-grade colour reproduction.

In short, whether you're racing at 200mph through the vivid streets of Mexico in *Forza Horizon 5*, exploring the neon-lit ghettos of *Cyberpunk 2077* or colour-grading HDR video footage, everything is presented with real pizzazz; it's a screen that you can't look away from.

Considering the size of the Strix Scar 18, the design is impressively ergonomic. In past years, Asus' Strix Scar laptops have tended to be big hunks of plastic. There's still some plastic, primarily to keep the weight down, but this time around the shell has gone through considerable refinement. If you want to show off by playing with the "AniMe" LED display on the lid, or the underbody RGB glow, be my guest, but for a more modest look you can switch those off and enjoy an unfussy, utilitarian design. And I don't only mean the aesthetic: as with the 16in model, I love the way you can quickly unlatch and slide off the bottom panel to replace or upgrade the RAM and SSD.

The keyboard and touchpad have been updated, too. On past models they both felt spongy, with an uncomfortable amount of flex on the deck. Here the touchpad feels smooth and solid, while each key has plenty of tactile depth. Asus takes advantage of the scale of the chassis to build in a full numeric keypad, too.

Last but not least, a new vapour chamber across the back and vents helps this laptop to keep its cool under load. To be sure, things get loud when you push it hard, but you don't have to worry about thermal throttling.

ABOVE A stunning screen and stellar performance make this a desirable laptop

PC PRO RECOMMENDED

"With uncompromising internal hardware, excellent connectivity and a dazzling mini-LED display, it's hard to see what more you could ask for"

Not everything about the Asus ROG Strix Scar 18 is a hit. In our battery tests it managed just over 90 minutes of gaming on a full charge; that's not a huge shock, especially considering the size of the display, but it's a limitation. I was also disappointed by the grainy quality of the 1080p webcam. It's good that it works with Windows Hello (previous models didn't), but I still expect better from a laptop costing this much.

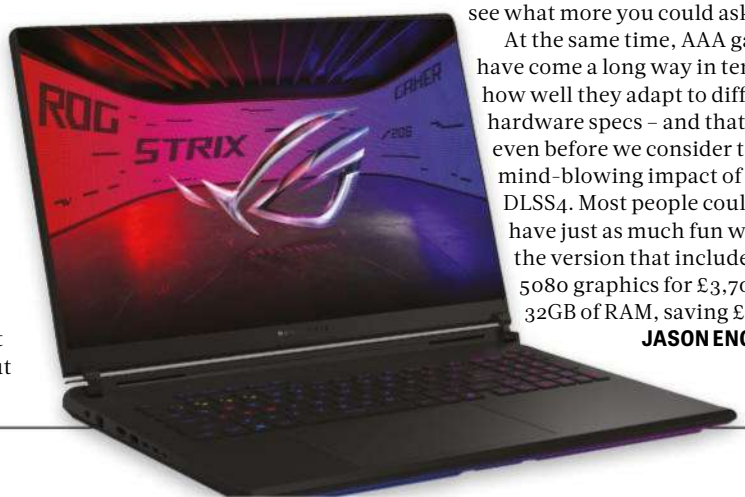
In fact, that's my major gripe with this laptop. Gaming laptops are always expensive, but £4,700 is a huge ask. It's a step up of around 15% over last year's model, even though that also used the most premium components available at the time of its release. There's no obvious reason for the hike, and it makes it harder to recommend the Strix Scar 18 to anyone who hasn't recently won the lottery.

In many ways, this is still one of the best gaming laptops you can buy. With uncompromising internal hardware, a premium makeover of the design, excellent connectivity and a dazzling mini-LED display, it's hard to see what more you could ask for.

At the same time, AAA games have come a long way in terms of how well they adapt to different hardware specs – and that's even before we consider the mind-blowing impact of DLSS4. Most people could have just as much fun with the version that includes RTX 5080 graphics for £3,700 and 32GB of RAM, saving £1,000.

JASON ENGLAND

BELOW A huge, uncompromising laptop with a huge, uncompromising price



Asus ROG Zephyrus G14 (2025)

Superb performance combines with a svelte design and mesmerising OLED to deliver big

SCORE ★★★★★

PRICE £2,667 (£3,200 inc VAT)
from asus.com

So there I was at the airport, my flight delayed by three hours. Normally in such a situation I'd bemoan my fate on social media, but with the Asus ROG Zephyrus G14 in my carry-on I had no complaints. I happily whiled away the time, engrossed in high-end gaming; when at last it was time to board, I was actually disappointed that I had to fold down the lid.

That's the beauty of a 14in gaming laptop. While I see the appeal of 16in and 18in screens, the smaller format is more practical wherever you may be. The ROG Zephyrus G14 looks beautiful, too, combining a clean, Apple-style aesthetic with a touch of excitement courtesy of a diagonal slash of subtle lighting on the back. I never felt less than proud to whip it out, whether I was in a business meeting, down the local pub or sitting in the departures lounge of Lisbon airport.

The CNC-milled aluminium construction also means it feels reassuringly durable, and Asus' glass-topped trackpad and chiclet keyboard continue to be the best in the business for gaming systems.

As with the Razer Blade 16 we reviewed last month (*see issue 369, p58*), the slim chassis lends itself to a Ryzen AI 9 HX 370 CPU, here partnered by Nvidia's RTX 5080 GPU and 32GB of RAM. Windows 11 has never felt so snappy, but as the CPU only contains eight cores to the 24 inside the Ultra 9 275HX it props up the table in Geekbench 6 multicore. Still, a score of 15,280 shows it will have no trouble multitasking. I could play multiple 4K video streams at once, with Adobe Photoshop and *Cyberpunk 2077* sitting open in the background. No matter how intense your workload is, the ROG Zephyrus G14 can take it.

The G14 can only deliver 110W to the GeForce RTX 5080 GPU compared to 175W from its rivals this month, and that shows in the performance tables on p77, but there's still plenty of gaming power here. Running *Cyberpunk 2077* in 1080p with ray-tracing and no DLSS, the ROG Zephyrus G14 averaged 50fps – but you can go much higher thanks to Nvidia's Multi Frame generation. I saw *Cyberpunk 2077* race up to an absurd 147fps at maximum quality settings, without any noticeable impact on latency.

All this high-end silicon makes the Zephyrus G14 a mightily impressive portable workstation, too. With its grown-up design, it works equally well as a creator machine as it does a gaming laptop, and it features all the connectivity most professionals need. There are two USB-C ports, one of which supports USB 4 (40Gbits/sec) and another USB 3.2 Gen 2 (10Gbits/sec). Two USB-A 3.2 Gen ports are also present, along with a microSD card slot and an HDMI 2.1 output. Not that there's any need for designers to hook up an expensive external display: the screen is Pantone validated.

In fact, the screen is an all-round winner. It's an OLED panel with a 3K resolution and 16:10 aspect ratio, which is ideal for productivity. The 120Hz refresh rate isn't up there with the fastest panels, but it's still smooth.

I must give a shout out to the speakers, too. The dual side woofers offer far more bass than I've come to expect from previous Zephyrus models, and they're more than loud enough to enjoy over the sound of the fans. That's an achievement, as those fans aren't quiet when you're driving the system hard, but they do their job of keeping the system cool enough to minimise thermal throttling.

While my impressions of the ROG Zephyrus G14 are almost entirely positive, the usual caveat applies – a seemingly unavoidable one, given how power-hungry gaming laptops are. Asus has managed to lengthen the gaming battery life by around three-quarters of an hour compared to last year's Zephyrus G14 model, but it still conked out after 1hr 45mins.

For desktop tasks, it fares better. You should squeeze up to six hours out of it on one charge, so you can be reasonably productive as long as you're not expecting to work through a long-haul flight.

Overall, it's hard to criticise the Asus ROG Zephyrus G14. Its killer combination of CPU and GPU, plus Nvidia's latest DLSS technology, unlocks incredible performance. Games shine on its crisp OLED display, while its tasteful looks and relatively portable design make it an appealing choice for professional tasks, too.

ABOVE The stylish and powerful Zephyrus G14 is equally as adept in creative tasks as it is in gaming

PC PRO RECOMMENDED

"It's the best mid-sized gaming laptop we've tested this year, and it will be quite some achievement for anyone to build something better"

Battery life is always going to be limited on a laptop like this, and it's not exactly a budget machine – you're undoubtedly paying a premium for the design and branding, over and above the manufacturing cost. However, you can save £500 by choosing the RTX 5070 Ti version, which still includes 32GB of RAM and the fast 2TB SSD included in my test system.

Besides, none of my criticisms takes away from the real appeal of the ROG Zephyrus G14: it's the best mid-sized gaming laptop we've tested this year, and it will be quite some achievement for anyone to build something better.

JASON ENGLAND

BELOW The stunning 3K OLED screen is ideal for productivity

Gigabyte Aorus Master 16 (2025)

A strong performer, but it doesn't feel as premium as its rivals – a fact reflected by its sub-£3,000 asking price

SCORE ★★★★☆

PRICE £2,417 (£2,900 inc VAT)
from scan.co.uk

No laptop costing almost £3,000 can be considered cheap, but the Aorus Master 16 is the only gaming laptop here to duck under that mark. But it does feel cheaper than its rivals. Though many gaming laptops use plastic to prevent overheating and reduce weight, Gigabyte's implementation of the material isn't perfect.

For instance, the lid features a lenticular material that reveals a ribbed pattern around the RGB-lit Aorus falcon logo. But the material feels like something I'd expect from a Happy Meal toy. At least on the lid, Gigabyte should have gone with premium aluminium. Then there's the Aorus logo displayed garishly across the touchpad, spilling onto the palm rest. Mix that with the RGB keyboard (including a handful of transparent keys), and there's no mistake that this laptop is meant for gamers. There's plenty of RGB, including a light bar underneath the palm rest and a second on the rear of the laptop. There's also a small RGB projection of the Aorus wordmark from the rear of the laptop.

The left side includes a Thunderbolt 5 port, USB-A 3.2 Gen 2 port, HDMI 2.1 and an Ethernet jack. On the right, there's another USB-A port, Thunderbolt 4, a headphone jack and a microSD card slot. I would have liked to see a full-size SD card slot on a laptop this size. My other slight complaint is that the power cable was bothersome as it juts out of the side about halfway along the left-hand side.

Although Gigabyte sells the Aorus Master 16 with an RTX 5090, the £2,900 price here buys you a 5080 to accompany Intel's popular Core Ultra 9 275HX. It can supply up to 175W of power to the GPU, and with the large chassis offering plenty of room for cooling we expected the Aorus Master to vie with the best RTX 5080 laptops. Which it did, even beating the RTX 5090 systems in *Borderlands 3* and *Shadow of the Tomb Raider*.

Nor will you have complaints outside of gaming, helped along by 32GB of RAM in our test system. It was actually the slowest of the Core 9 Ultra systems in Geekbench 6, but in practice this is an incredibly responsive PC. And it redeemed itself in our video-encoding test, taking third place with 2mins 17secs.

Like the HP and Lenovo, the Aorus includes a 16in OLED panel with a 240Hz refresh rate. While it only covers 81% of the DCI-P3 space, when I explored a forest at sunrise in *Alan Wake 2* the green foliage was vibrant and the entire scene lightly coloured by an appropriate orange tint. It's a brighter panel than the HP's but only just, with a 378cd/m² peak.

Gigabyte's keyboard features poppy scissor switches that provide a comfortable bounce while writing and gaming. I wish the keycaps were larger, and there's clearly room for them, as Gigabyte has speaker grille patterns on each side of the keyboard. But not actual speaker grilles, with the audio here another sign of weakness: they're passable for listening to music, but far better tuned for gaming. The 1080p webcam is fine, if too cool for my liking.

The touchpad is a generous size, with a mechanical click that works well. It's smooth and proved a fine partner for Windows gestures.

Removing the bottom cover requires dispatching 12 screws. There are three sizes here, so be sure to keep track of which ones go where. You're rewarded by a second empty M.2 slot, with the first occupied by a 2TB SSD.

ABOVE The Aorus Master 16 is the cheapest laptop in this group test

This was surprisingly slow in our real-world 25GB file-transfer test, at 665MB/sec compared to the 1,500MB/sec we've become used to, but this didn't affect its day-to-day speed.

You'll also discover a 99.2Wh battery, again typical for a gaming laptop, and it didn't tear up any records in our battery life tests: 5hrs 2mins under light use and 1hr 40mins in PCMark's gaming test.

"It's cheaper than rivals, but when you're paying this much you should expect a premium device, not one with a plasticky build"

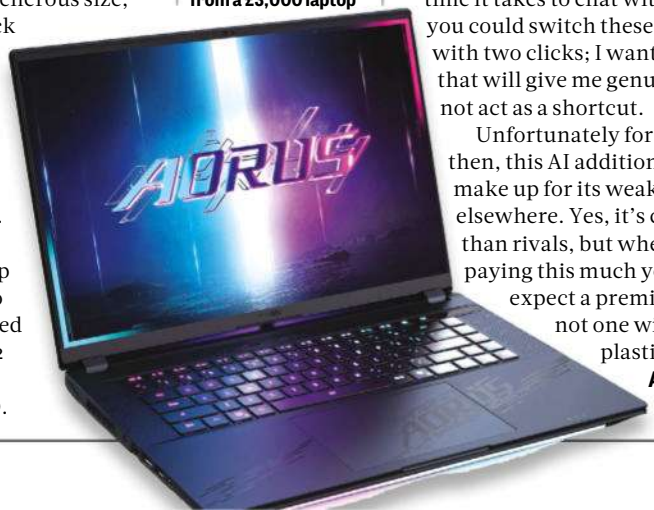
Gigabyte is mercifully light on the amount of software it includes on the Aorus Master. It boils down to two apps: Gigabyte Speed and GiMate. Gigabyte Speed tries to prioritise gaming traffic on your network, but GiMate is a system monitor that, Gigabyte claims, has AI capabilities.

These aren't obvious. Its primary use is for changing performance modes, checking CPU and GPU speeds and adjusting system settings, much like previous iterations. There's an AI agent, and if you tell it you want to play a game it will switch to Game Mode. Or you can write "I'm going to a meeting" and it will downclock in "Online Meeting Mode." But in the time it takes to chat with the LLM, you could switch these manually with two clicks; I want something that will give me genuine insight, not act as a shortcut.

Unfortunately for Gigabyte, then, this AI addition doesn't make up for its weaknesses elsewhere. Yes, it's cheaper than rivals, but when you're paying this much you should expect a premium device, not one with a plasticky build.

ANDREW E FREEDMAN

BELOW Sadly, the build quality is not what you'd expect from a £3,000 laptop



HP Omen Max 16 (2025)

Promises so much with its cutting-edge components and gorgeous OLED display, but ultimately disappoints

SCORE ★★★☆☆

PRICE As reviewed, £3,333 (£3,999 inc VAT) from hp.com

Not much makes me happier than a powerful gaming laptop, and the HP Omen Max 16 is one of the most powerful around. With an Intel Core Ultra 9 275HX CPU and top-of-the-line Nvidia GeForce RTX 5090 graphics, it's an unbeatable specification – and the OLED screen is a treat for the eyes, too.

The design is chunky – that's inevitable for a 16in gaming laptop – but its 2.7kg weight is on the heavy side even compared to its competitors this month. The overall shape is clean and simple, but is decorated with several attention-seeking design features: aside from the lightbar and RGB keys, there's a glossy black Omen logo on the lid, and another "O16" logo below the keyboard, along with text in an alien alphabet that I'm not going to try to decipher.

The bezels on the display are pleasingly thin, with the webcam on top and a much appreciated privacy shutter. HP scatters plenty of connections around the sides, with twin Thunderbolt 4 ports, two USB-A 10Gbits/sec ports, HDMI 2.1, Ethernet and a headphone/microphone jack – not to mention Wi-Fi 7.

But the big attraction is the screen. The OLED panel stunned me with its fever dream of colours, while a native resolution of 2,560 x 1,600 and 240Hz refresh rate means that games will look both sharp and smooth.

My only caveat is that for the best experience you'll want to play in a dark room, as the panel isn't bright enough to overcome glossy glare. I noticed this not only when gaming, but when watching the trailer for the upcoming *Lilo & Stitch* film; bright ocean scenes looked so incredible I felt I could literally dive in, but when the action moved to Lilo's dark room I was distracted by reflections.

I was a little disappointed by the audio, too, with the bottom-firing speakers producing mediocre sound. This isn't just about immersion; it can actually affect gameplay. In *Marvel Rivals*, there's a cacophony of noises and warnings you must pay attention to, but on these speakers I sometimes struggled to make out the dialogue. HP seems to anticipate that you'll be using this laptop with a headset: it includes a licence for DTS Sound Unbound, but only for headphones.

On the plus side, the keyboard is a pleasure to use. I like a bit of kick and bounce in my keyboard, and the HP Omen Max 16 has a great feel. The size of the keys gives my fingers enough room to breathe, too. I don't like the almost non-existent spacing between them, but there's enough texture on the keytops to guide your fingers to the right place, and space on the deck for your palms to rest comfortably.

With all that out of the way, it's time to talk about the gaming performance. And I'm torn. While the Omen Max 16 has enough power to tear through any game you care to try, its benchmark scores didn't always match up to the competition. Arguably these raw results don't matter as much any more, as the GPU supports DLSS 4 and that can double or triple a game's native frame rate. In compatible games, a difference of 5-15fps between this and competing laptops is almost academic.

The HP Omen Max 16 also throws some heavy punches in desktop performance, thanks to its 24-core CPU and 32GB of RAM. Skipping back and forth between a few dozen Chrome tabs and a handful of YouTube videos while *Marvel Rivals* downloaded in the background felt like a breeze. That's borne out by a terrific performance in the Geekbench 6 benchmark.

While this isn't marketed as a Copilot+ PC, the CPU and GPU together are also more than powerful enough to run AI-powered features such as Recall, Windows Studio Effects and Live Captions. There aren't any obvious HP-branded AI features on the Omen Max 16, apart from AI Noise Removal in the myHP audio settings, but you do get the Omen Gaming Hub. This is where you can tune your performance and monitor system vitals. Head to the myHP tool for additional display, audio and battery life settings.

With so much high-end hardware, the HP Omen Max 16 doesn't run for long on battery power. In the PCMark 10 gaming test, it lasted for 1hr 26mins away from the mains: that's not bad enough to ruin the deal, but once again rival machines do better.

ABOVE A top-of-the-range CPU and GPU didn't result in chart-topping results

"The Omen Max 16 throws some heavy punches in desktop performance, thanks to its 24-core CPU and 32GB of RAM"

I've been using an older HP Omen laptop as my gaming PC for quite a while now, so I had high hopes for the HP Omen Max 16. And if I'm honest, I was disappointed: for this price I was expecting best-in-class gaming performance and battery life, and the Omen Max 16 delivers neither. The sound is a letdown too, if you want to enjoy your games out loud. There are excellent 16in alternatives on test this month, such as the Lenovo Legion Pro 7i Gen 10 opposite.

Even so, if you like HP's Omen laptops then there's enough performance here to make almost anyone happy – and you simply can't beat the sumptuous 16in OLED display. As long as you're not planning to play in direct sunlight, this laptop delivers one of the best all round visual experiences I've seen.

RAMI TABARI

BELOW The display is also superb, as long as you're in a darkened room

Lenovo Legion Pro 7i Gen 10

A beast that delivers a new level of performance to take advantage of the bright 240Hz OLED panel

SCORE ★★★★★

PRICE As reviewed, £2,700 (£3,240 inc VAT) from lenovo.com

Lenovo's latest 16in gaming laptop justifies its high price with a one-two punch of killer performance and a superb display. Frankly it's one of the most attractive machines I've ever reviewed.

That has much do with its OLED display. I've always loved the bright whites, inky blacks and sharp contrast of OLED panels, and it makes everything you do on this laptop look amazing, especially gaming in HDR and Dolby Vision. Every time I opened the lid, I was struck by how rich and colourful the screen looked.

I was even more impressed at the panel's technical performance. This thing is bright, more than 100cd/m² brighter than the HP opposite, with an SDR peak of 464cd/m² that climbs all the way up to 1,000cd/m² when viewing HDR content – and at the same time, it manages to cover over 100% of the DCI-P3 gamut (139% volume). Its accuracy is excellent, too, with an average Delta E of 0.29. You don't need this level of quality to enjoy games, but these are all pluses if you need a laptop for more creative tasks.

The screen is far from the only outstanding thing about the Legion. With its Intel Core Ultra 9 275HX CPU and Nvidia GeForce RTX 5080 GPU, it's capable of running the latest games at more than 60 frames per second even at the screen's native 2,560 x 1,600 resolution.

That's thanks to the latest generation of Nvidia's DLSS upscaling tech, which can smooth performance by inserting AI-generated frames between "real" frames. I admit that I was initially sceptical of this feature, but having tried it in several titles I can confirm that it works very well, enabling beautifully fluid gaming with no noticeable graphical issues or input latency.

Even without DLSS, the Lenovo Legion Pro 7i is no slouch. Our benchmarks were all carried out at 1080p with no upscaling, and they show the Legion Pro 7i holding its own comfortably against competing systems. While it doesn't quite match the HP Omen Max 16 or the Asus ROG Strix Scar 16, that's to be expected since those systems come with a more powerful RTX 5090 GPU. You can configure the Lenovo with an RTX 5090, but that costs an extra £700.

As with all the laptops here other than the Zephyrus G14, the Legion Pro 7i is a hefty beast, weighing 2.7kg. It doesn't look bulky, though: every time I picked up this machine I was surprised by its weight, relative to its sleek and elegant chassis.

Other design plus points include the easy-open lip on the top lid, the intuitive function keys – I love the way you can hit the Fn key and see all the relevant key combos light up on the keyboard – the reassuring 1.8mm of key travel and the side-mounted shutter switch that disables the webcam when you want privacy. Gaming laptops often try too hard to be edgy and not hard enough to be ergonomic or practical, but the Legion Pro 7i can't be accused of that.

Around the edges you'll also find all the ports you need for serious PC gaming. The right-hand side offers a pair of USB-A ports, a headphone jack and an Ethernet socket for wired networking; on the left you get one regular USB-C port, one Thunderbolt 4 port, another USB-A port, HDMI 2.1 and a barrel-type power socket – although you can also charge the laptop via the USB-C port if you prefer. Some of these ports are set further forward than usual, but I didn't have any problems with this in general use.

As impressive as the Lenovo Legion Pro 7i is, there are some caveats you should be aware of before buying one. As always with gaming laptops, you pay a premium for the portable design without benefitting from a laptop that you'll want to carry around with you. And if you do, it won't last long away from the mains: it lasted a shade over an hour and a half of simulated gaming in the PCMark 10 battery benchmark test, and in *Cyberpunk 2077* I got barely more than an hour of game time before the laptop was down to 10% battery and alerting me to plug it in.

ABOVE The Legion Pro 7i is a stunning laptop with a screen that will blow you away

PC PRO ★★★★★ A-LIST

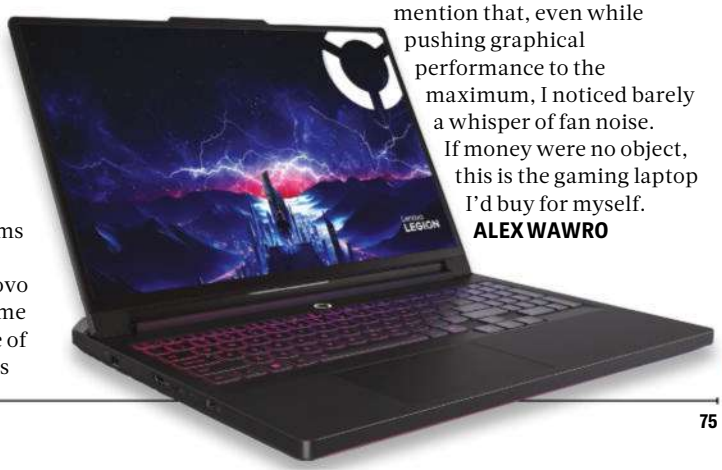
"The elegant design makes it easy on the eyes and a joy to use. Games look gorgeous on the bright OLED screen"

At least you can improve matters by fine-tuning the performance settings using the Lenovo Vantage app. Unlike the bloatware provided by some laptop vendors, this offers detailed and actually useful power controls, including an overclocking button that's enabled when the laptop is plugged in via its primary charger.

Overall, the Legion Pro 7i is the standout 16in gaming laptop in this group. Inescapably, the format comes with compromises on price, weight and battery life, but the elegant design is easy on the eye and a joy to use. Games look gorgeous on the bright OLED screen, with beautifully smooth frame rates – and I should also mention that, even while pushing graphical performance to the maximum, I noticed barely a whisper of fan noise. If money were no object, this is the gaming laptop I'd buy for myself.

ALEX WAWRO

BELOW There's plenty of connectivity on offer, including a Thunderbolt 4 port



MSI Raider 18 HX AI A2XW

A punchy display and audio combo ensure this laptop feels premium, but MSI asks too much for 5080 graphics

SCORE ★★★★☆

PRICE As reviewed, £3,500 (£4,200 inc VAT) from scan.co.uk

Powerful gaming laptops command premium prices, and the MSI Raider is no different. This RTX 5080 system costs £4,200, but you can buy an RTX 5090 version for £4,499 from Amazon.

Both models feature a generous 4TB of storage spread across a pair of 2TB drives, and the result is excellent speed: 2,252MB/sec in our real-world file-copy tests. Of the other systems here, only the Lenovo Legion Pro 7i breached 2,000MB/sec.

And this laptop is all about speed, with the Raider hitting a maximum operating power of 260W thanks to MSI's OverBoost Ultra technology. This led to atrocious battery life in our light-use test, 2hrs 33mins, but it lasted for a more respectable 1hr 46mins when we switched to gaming.

More importantly to most, it easily hit over 100fps at 1080p in most games, although more difficult titles such as *Black Myth: Wukong* and *Cyberpunk 2077* proved a challenge. This is where DLSS 4 and frame generation come in. With DLSS 4 enabled at the 18in panel's 2400p resolution and High settings, I was easily able to keep a stable 47fps in *Monster Hunter Wilds*. That jumped up to 70fps with frame generation enabled. I saw similar improvements in *Avowed*, going from 77fps at 2400p on High settings with only DLSS 4 to 115fps with frame generation also toggled on. Without either, the game was hitting 46fps.

Lastly, I used the Raider to take on my *Final Fantasy XIV: Dawntrail* dailies (recurring activities that give rewards), and averaged 80fps with the laptop at 2400p and High (Desktop) settings without any supersampling. Dropping the graphics down to High (Laptop) saw those frame rates capped at 110fps, generally staying in the ballpark of 95fps during gameplay.

Curiously the Raider was one of the slower systems in the single-core Geekbench 6 test, but then topped the charts for both the multicore section and the HandBrake encoding test. But with a 24-core Intel Core Ultra 9 285HX and 64GB of RAM inside, this laptop should never feel slow.

During my hands-on testing, nothing I threw at the Raider made the fans kick on. Except for Cinebench R23: MSI claims this laptop can break the 40,000 mark, but in our tests it peaked at 39,414. Which is still pretty darn impressive.

Then again, it should be at this size. MSI describes the Raider as "large and in charge", but even that undersells this 3.6kg behemoth that measures 404mm wide and 32.1mm thick at its chunkiest point. I don't own a backpack that's large enough to contain it. In return MSI gives you every possible port: two Thunderbolt 5, three USB-A 3.2 Gen 2, 2.5Gbits/sec Ethernet, a full-size SD Express card slot and an HDMI 2.1 port.

My favourite detail of this chassis is the alternating red and black vent covers along the rear and sides of the chassis, which add contrast to the hefty design. MSI takes a minimalist approach to RGB lighting, with a thin strip below the keyboard deck and a backlit MSI logo on the cover panel.

The keyboard deck is similarly sparse, with a few vents for the onboard audio and additional thermal control, which leaves most of the width for a full-size keyboard, number pad and a large touchpad. Naturally, per-key RGB lighting is here, while the board is designed by SteelSeries. It has a solid amount of bounce with nicely spaced keys to avoid mistypes. The keys are quiet but have a good amount of key travel.

Then we come to the 18in, 3,840 x 2,400, 120Hz matte mini-LED panel. In *Avowed*, the corals along a beach stopped me in my tracks thanks to their crisp detail against the stormy grey skies and weather-beaten wood of a wrecked ship in the background. This feeling was backed up in our tests, with an average Delta E of 0.25 and covering 83% of the DCI-P3 gamut (although others here go higher still). It hit a peak brightness of 668cd/m² in SDR content, upping to 793cd/m² with HDR active.

ABOVE The Raider 18 is a huge, powerful and ridiculously expensive laptop

The audio setup is similarly impressive, with two woofers and four tweeters bringing sheer volume and high fidelity. Normally gaming laptops struggle with gentle ballads, but I found no such problems here. I was less impressed by the 1080p IR webcam, with its washed-out colours.

"This is the only laptop on test that does full justice to the phrase 'desktop replacement'. It offers superb all-round and gaming performance"

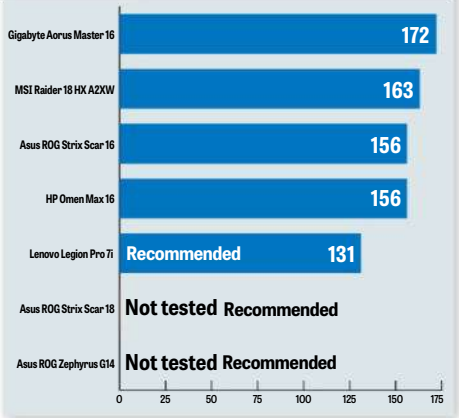
Software-wise, there's little to shout about: the MSI Center app controls your power settings and includes an "AI Engine" to help, but you're better off spending time with Intel's AI Playground and ChatRTX.

So to the big question: is the Raider 18 worth the high price? Not for everyone: there are so many excellent gaming/creative laptops here that cost more than £1,000 less (including the 16in Medion Erazer Beast on p52). Yet this is the only laptop on test this month that does full justice to the phrase "desktop replacement". It offers superb all-round and gaming performance, a bright, giant mini-LED display, a comfortable keyboard and powerful audio. But if you're spending this much, it's surely worth opting for the RTX 5090 version for £299 more.

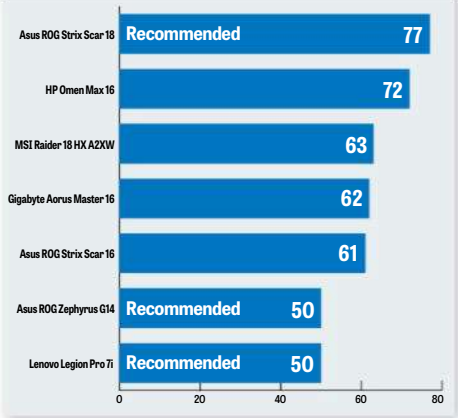
MADELINE RICCHIUTO

BELOW The enormous mini-LED display has a desktop-like resolution of 3,840 x 2,400

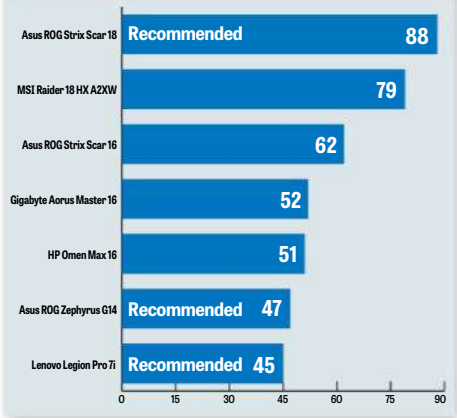
Borderlands 3 (1080p Ultra)


Gigabyte Aorus Master 16 172
MSI Raider 18 HX A2XW 163
Asus ROG Strix Scar 16 156
HP Omen Max 16 156
Lenovo Legion Pro 7i Recommended 131
Asus ROG Strix Scar 18 Not tested Recommended
Asus ROG Zephyrus G14 Not tested Recommended
0 25 50 75 100 125 150 175

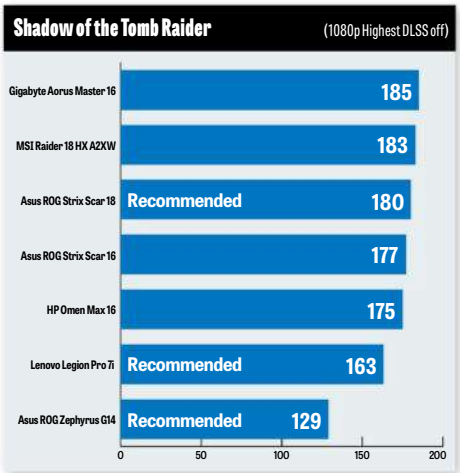
Cyberpunk 2077 (1080p RT Ultra DLSS off)


Asus ROG Strix Scar 18 Recommended 77
HP Omen Max 16 72
MSI Raider 18 HX A2XW 63
Gigabyte Aorus Master 16 62
Asus ROG Strix Scar 16 61
Asus ROG Zephyrus G14 Recommended 50
Lenovo Legion Pro 7i Recommended 50
0 20 40 60 80

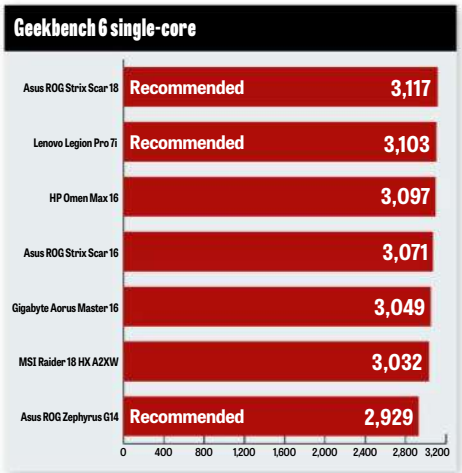
Black Myth: Wukong (1080p Cinematic DLSS off)


Asus ROG Strix Scar 18 Recommended 88
MSI Raider 18 HX A2XW 79
Asus ROG Strix Scar 16 62
Gigabyte Aorus Master 16 52
HP Omen Max 16 51
Asus ROG Zephyrus G14 Recommended 47
Lenovo Legion Pro 7i Recommended 45
0 15 30 45 60 75 90

Shadow of the Tomb Raider (1080p Highest DLSS off)


Gigabyte Aorus Master 16 185
MSI Raider 18 HX A2XW 183
Asus ROG Strix Scar 18 Recommended 180
Asus ROG Strix Scar 16 177
HP Omen Max 16 175
Lenovo Legion Pro 7i Recommended 163
Asus ROG Zephyrus G14 Recommended 129
0 50 100 150 200

Geekbench 6 single-core


Asus ROG Strix Scar 18 Recommended 3,117
Lenovo Legion Pro 7i Recommended 3,103
HP Omen Max 16 3,097
Asus ROG Strix Scar 16 3,071
Gigabyte Aorus Master 16 3,049
MSI Raider 18 HX A2XW 3,032
Asus ROG Zephyrus G14 Recommended 2,929
0 400 800 1,200 1,600 2,000 2,400 2,800 3,200

Geekbench 6 multicore

MSI Raider 18 HX A2XW 21,851
Lenovo Legion Pro 7i Recommended 19,829
HP Omen Max 16 19,822
Asus ROG Strix Scar 16 19,597
Asus ROG Strix Scar 18 Recommended 19,553
Gigabyte Aorus Master 16 19,175
Asus ROG Zephyrus G14 Recommended 15,280
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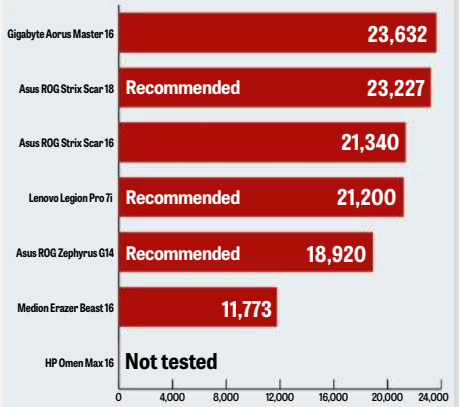
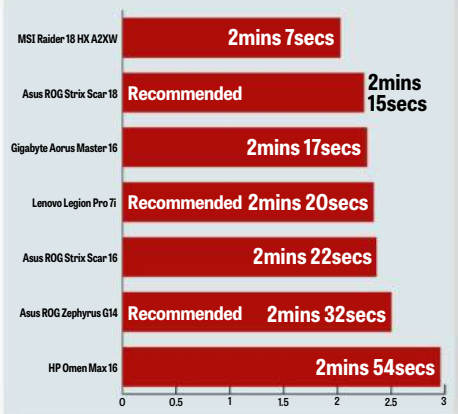
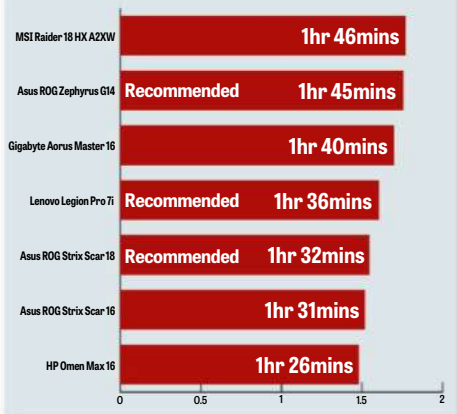
Geekbench AI (ONNX GPU quantized)


Gigabyte Aorus Master 16 23,632
Asus ROG Strix Scar 18 Recommended 23,227
Asus ROG Strix Scar 16 21,340
Lenovo Legion Pro 7i Recommended 21,200
Asus ROG Zephyrus G14 Recommended 18,920
Medion Erazer Beast 16 11,773
HP Omen Max 16 Not tested
0 4,000 8,000 12,000 16,000 20,000 24,000

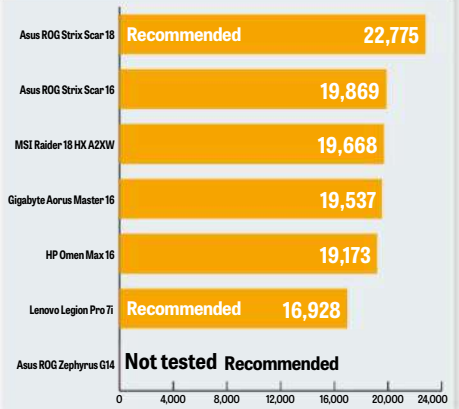
HandBrake


MSI Raider 18 HX A2XW 2mins 7secs
Asus ROG Strix Scar 18 Recommended 2mins 15secs
Gigabyte Aorus Master 16 2mins 17secs
Lenovo Legion Pro 7i Recommended 2mins 20secs
Asus ROG Strix Scar 16 2mins 22secs
Asus ROG Zephyrus G14 Recommended 2mins 32secs
HP Omen Max 16 2mins 54secs
0 0.5 1 1.5 2 2.5 3

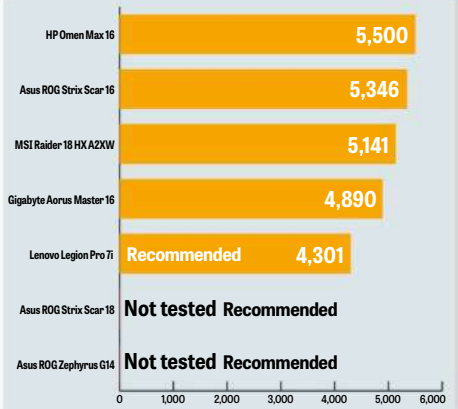
Battery life (PCMark gaming)


MSI Raider 18 HX A2XW 1hr 46mins
Asus ROG Zephyrus G14 Recommended 1hr 45mins
Gigabyte Aorus Master 16 1hr 40mins
Lenovo Legion Pro 7i Recommended 1hr 36mins
Asus ROG Strix Scar 18 Recommended 1hr 32mins
Asus ROG Strix Scar 16 1hr 31mins
HP Omen Max 16 1hr 26mins
0 0.5 1 1.5 2

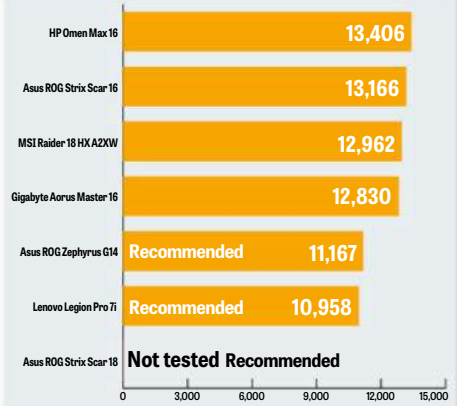
3DMark Time Spy


Asus ROG Strix Scar 18 Recommended 22,775
Asus ROG Strix Scar 16 19,869
MSI Raider 18 HX A2XW 19,668
Gigabyte Aorus Master 16 19,537
HP Omen Max 16 19,173
Lenovo Legion Pro 7i Recommended 16,928
Asus ROG Zephyrus G14 Not tested Recommended
0 4,000 8,000 12,000 16,000 20,000 24,000

3DMark Speed Way


HP Omen Max 16 5,500
Asus ROG Strix Scar 16 5,346
MSI Raider 18 HX A2XW 5,141
Gigabyte Aorus Master 16 4,890
Lenovo Legion Pro 7i Recommended 4,301
Asus ROG Strix Scar 18 Not tested Recommended
Asus ROG Zephyrus G14 Not tested Recommended
0 1,000 2,000 3,000 4,000 5,000 6,000

3DMark Port Royal


HP Omen Max 16 13,406
Asus ROG Strix Scar 16 13,166
MSI Raider 18 HX A2XW 12,962
Gigabyte Aorus Master 16 12,830
Asus ROG Zephyrus G14 Recommended 11,167
Lenovo Legion Pro 7i Recommended 10,958
Asus ROG Strix Scar 18 Not tested Recommended
0 3,000 6,000 9,000 12,000 15,000

BEST VPNs STAY SAFE IN 2025

WE PUT A DOZEN VPN SERVICES THROUGH THE WRINGER TO DETERMINE THE BEST FREE OFFERINGS AND WHICH ARE WORTH PAYING FOR

Is there any technology purchase quite as fraught with peril as a VPN? Or one where you need to place greater trust in the company you're handing your money to? Because with that money you're also giving them access to all your data, including confidential information such as banking details.

But fear not, for we are here so you can avoid the pitfalls. Over the next 16 pages, we give you a side-by-side comparison in our feature table on p80, provide a buyer's guide on p82, break down their performance results on p94 and show you well they performed when we used region-shifting to watch iPlayer, Netflix and Amazon Prime Video shows from abroad.

That's quite apart from detailed reviews, starting with extended reviews of products that were vying for awards. In every review, we explain how the company handles your data (going back to the key question of trust), any exceptional features and whether you need to watch out for a nasty renewal fee when your contract is up for renewal.

And if you don't want to spend money on a VPN, only calling upon its services occasionally, then check out our rundown of the best free VPNs on p89.

CONTRIBUTOR: KG Orphanides

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Windscribe 93

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Region-shifting streaming results 95

	Avast SecureLine VPN	CyberGhost	LABS WINNER ExpressVPN	RECOMMENDED Mullvad	NordVPN
Overall rating	★★☆☆☆	★★★☆☆	★★★★★	★★★★★	★★★★☆
Supplier	avast.com	cyberghostvpn.com	expressvpn.com	mullvad.net	nordvpn.com
Pricing					
Free version?	✗	✗	✗	✗	✗
Best deal*	3yr £93 (£112 inc VAT)	2yr 4mth £50 (£60 inc VAT)	2yr 4mth $140 (£113)	€5 (£4.34) per month	Basic, 2yr 3mth £65 (£77 inc VAT)
First year subscription*	£34 (£40 inc VAT)	6mth £31 (£37 inc VAT)	$100 (£81)	€60 (£52)	Basic, £47 (£56 inc VAT)
Renewal price*	£67 (£80 inc VAT)	£50 (£60 inc VAT)	$100 (£81)	€5 (£4.34)	Basic, £117 (£140 inc VAT)
Lowest price per month in GBP inc VAT*	£3.11	£1.78	£4.04	€5 (£4.34)	£2.85
Anonymous payment options	✗	Cryptocurrency	Cryptocurrency, gift cards	Cryptocurrency, cash, gift cards	Cryptocurrency
Trial options	60 days, requires card details	45-day money-back guarantee	30-day money-back guarantee	30-day money-back guarantee	30-day money-back guarantee
Monthly subscription price (inc VAT if applicable and using current exchange rates)	✗	£13.07	$13 (£10.46)	€5 (£4.34)	Basic, £11.99
Features					
Number of simultaneous devices	10	7	8	5	10
Kill switch	✓	✓	✓	✓	✓
Split tunnelling	Android app only	Android, Windows	✓	✓	✓
Obfuscation	✓	✓	✗	✓	✓
Port forwarding	✗	✗	ExpressVPN routers only	✗	✗
RAM disk servers	✗	✓	✓	✓	✓
Post-quantum safe tunnels	✗	✗	✓	✓	✓ (not on macOS)
Supported protocols					
OpenVPN	✓	✓	✓	✓	✓
WireGuard	✓	✓	✗	✓	✓
SOCKS5 Proxy	✗	✗	✗	✗	✓
PPTP	✗	✗	✓	✗	✗
L2TP/IPSec	✗	✗	✓	✗	✓
IKEv2/IPSec	✗	✓	✗	✗	✗
Other	✗	✗	Lightway	✗	✗
Geographic info					
Number of territories	38	100	94	49	118
Total number of servers (active at time of review)	54	5,900	3,000+	683	7,000
Country based in	Czech Republic	Romania (parent company in UK)	British Virgin Islands (parent company in UK)	Sweden	Panama
Browser plugins					
Chrome	✓	✓	✓	✗	✓
Firefox	✓	✓	✓	✓	✓
Other	Opera, Edge, Avast Secure Browser (integrated)	✗	Safari	✗	✗
OS with dedicated apps					
Windows	✓	✓	✓	✓	✓
macOS	✓	✓	✓	✓	✓
Linux	✗	✓	✓ (command line)	✓	✓ (command line)
Android	✓	✓	✓	✓	✓
iOS	✓	✓	✓	✓	✓
Other	✗	Fire TV	Kindle Fire, Fire TV	✗	✗

*Where prices are in dollars or euros, the rate is correct as of 28 April 2025

			RECOMMENDED	RECOMMENDED			
	Norton VPN	Private Internet Access	Proton VPN Plus	Surfshark	TunnelBear	VyprVPN	Windscribe
	★★☆☆☆	★★★☆☆	★★★★★	★★★★★	★★★★☆	★★★☆☆	★★★★☆
	uk.norton.com	privateinternetaccess.com	protonvpn.com	surfshark.com	tunnelbear.com	vyprvpn.com	windscribe.com
	✗	✗	✓ (limited endpoints)	✗	✓ (2GB/month)	✗	✓ (10GB/month, limited endpoints)
	Standard, 1yr £17 (£20 inc VAT)	3yr 4mth £54 (£65 inc VAT)	2yr £72 (£86 inc VAT)	Starter, 2yr 3mth £40 (£48 inc VAT)	Unlimited, 3yr $120 (£90)	2yr £60 (£72 inc VAT)	1yr $69 (£52)
	Standard, £17 (£20 inc VAT)	£27 (£32 inc VAT)	£41 (£49 inc VAT)	Starter, 1yr 3mth £39 (£47 inc VAT)	Unlimited, $60 (£45)	£45 (£54 inc VAT)	$69 (£52)
	Standard, £34 (£40 inc VAT)	3yr £54 (£65 inc VAT)	£60 (£72 inc VAT)	Starter £48 (£58 inc VAT)	Unlimited, $10 (£8)	2yr, £60 (£72 inc VAT)	$69 (£52)
	£1.67	£1.63	£3.58	£1.77	£2.50	£3	£4.46
	✗	Cryptocurrency, gift cards	Cryptocurrency, cash	Cryptocurrency	✗	✗	Cryptocurrency
	7-day free trial (requires payment details)	30-day money-back guarantee	30-day money-back guarantee	30-day money-back guarantee	✗	30-day money-back guarantee	✗
	✗	£9.99	£8.09	£14.75	$10 (£7.46)	£9	$9 (£6.72)
	1/5/10	"Unlimited"	Free 1; Premium 10	"Unlimited"	"Unlimited"	5	Free 1, Pro "Unlimited"
	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓
	✗	✓	✓	✓	✓	✓	✓
	✗	✓	Windows and Linux, for paying users	✗	✗	✗	✓
	✗	✓	✗	✓	✗	✗	✓
	✗	✗	✗	✗	✗	✗	✓
	✓	✓	✓	✓	✓	✓	✓
	✗	✓	✓	✓	✓	✓	✓
	✗	✓	✗	✗	✗	✗	✓
	✗	✗	✗	✗	✗	✓	✗
	✓	✓	✗	✗	✗	✓	✗
	✗	✗	✓	✓	✓	✗	✓
	✗	✗	✗	✗	✗	✗	✗
	29	83	5/117	100	45	64	64
	Not stated	3,341	12,000	3,200	8,000	700	700
	US/Canada	US (parent company in UK)	Switzerland	Netherlands	Canada (parent company in US)	US	US
	✗	✓	✓	✓	✓	✗	✓
	✗	✓	✓	✓	✓	✗	✓
	✗	Opera	✗	✗	Edge	✗	Edge
	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓
	✗	✓	✓ (command line)	✓ (command line)	✗	✓ (command line)	✓
	✓	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓	✓
	✗	✗	✗	✗	✗	✗	Fire TV, Nvidia Shield

Key factors to consider when choosing a VPN

When investing in a VPN it makes sense to know exactly what features you need and those you don't. It could end up saving you a lot of money

Let's start with the basics: what is a virtual private network (VPN)? In short, it's an encrypted connection from your device to a remote server. VPNs used to be common in the workplace, allowing those working remotely to access an on-premises or cloud-based office network.

Here, though, we're looking at consumer VPN providers. These subscription-based services provide an encrypted tunnel for all your internet traffic and typically provide endpoints in scores of different locations, allowing you to virtually locate yourself in any of those places.

Privacy is a major selling point for VPN services. Data going to and from your device through an encrypted link to a remote server can't be inspected by your ISP or, typically, monitoring tools on a local network. But that also means your VPN provider *can* see all your data, so you need to know that you can trust them.

Region-shifting

The most popular reason for using a VPN is to access region-locked entertainment content, such as the extended movie catalogue of US Netflix, national TV from your native country, or US newspapers that have blocked UK and EU readers rather than comply with our more stringent data protection laws.

RIGHT **VPNs allow you to move virtually to locations around the world**

Research the service you're going with, any features and restrictions that may apply, and any local laws that may affect its activities

Media licence holders are, for obvious reasons, unhappy about this and have pressured streaming companies to ensure compliance. As a result, there's a constant arms race between streaming services that are increasingly blocking IP ranges they think are likely to be used by VPN providers, and VPN services, which are seeking to obtain residential IP addresses from blocks assigned to home users.

Some VPN services, such as Mullvad and Avast SecureLine, don't prioritise region-shifting for streaming and don't advertise their services on that basis.

But most major VPN providers make efforts to give you access to region-locked content. We were impressed by the number of VPN services that allowed us to watch this (*see p95 for a quick overview*). Perhaps that shouldn't be surprising, as most services we test this month are, to a greater or lesser extent, committed to an arms race against geo-locking. VPN providers that focus on region-shifted streaming extensively acquire and test appropriate IP address blocks to evade anti-VPN measures by the likes of Netflix, Amazon and the BBC.

BELOW **VPNs offer a lifeline to those who want to watch BBC TV when abroad**

Privacy

If you're primarily interested in a VPN for privacy, you should know exactly what you need privacy from. The archetypical example is a public, office or even home network on which you'd like to protect yourself from sniffing attacks that seek to capture data as you pass it back and forth (though this is somewhat less of an issue than it once was, as HTTPS has become ubiquitous).

Then there's the desire to evade content filtering. This can include national-state or ISP level filters, ranging from the great firewall of China to blocks designed to keep adult content out of the hands of anyone who can't – or doesn't wish to – hand over ID to prove that they're over 18.

A VPN provider is essentially an alternative ISP. This is great if you don't trust your ISP not to either restrict your access to certain websites, apply content-based throttling, or snoop on your activities, but you're now entrusting that same data to a random VPN provider.

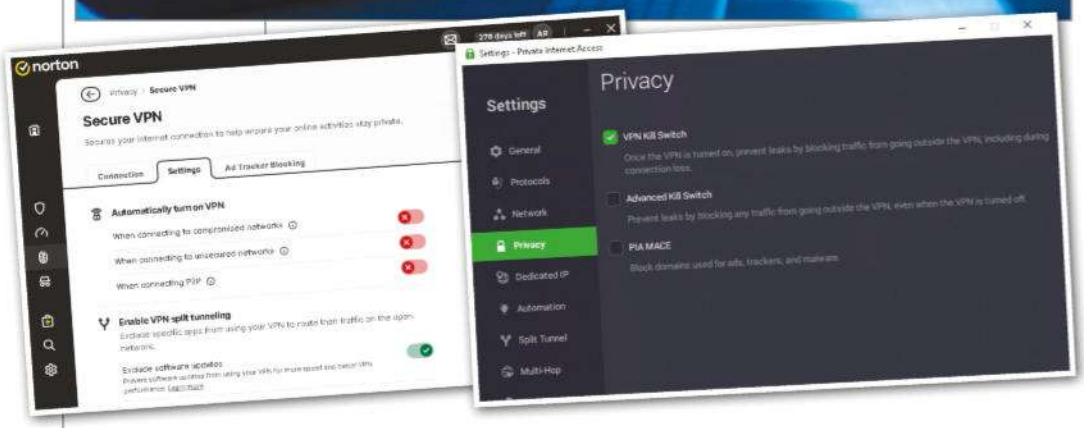
Research the service you're going with, any features and restrictions that may apply, and any local laws that may affect its activities. Every VPN provider in this Labs test promises to keep no identifying user logs, but many jurisdictions have laws that can be used to compel a VPN provider to collect or hand over what data they have.

RIGHT Many users have good reason to want to protect their online privacy

The best services are up front about this and take measures to mitigate risk. These include RAMdisk servers, in which everything is stored in volatile memory that's wiped on reboot or power down; allowing customers to pay anonymously using cash, gift cards or cryptocurrency; blocking endpoint servers in specific countries from activity such as torrenting, which comes with a legal obligation to keep logs, and headquartering themselves in countries with privacy-friendly laws – Panama, Switzerland and the British Virgin Islands are popular choices. It's worth noting that even privacy-friendly Switzerland is party to international law enforcement agreements.

Some VPN providers that claimed to keep no logs have handed over logs upon receiving a court order. Others, particularly those that primarily advertise themselves on mobile app stores, have been caught spying on users or collecting user data to sell to advertisers. This group test doesn't include any VPN provider that we regard to be disreputable in this way.

While any service that you don't have full control of carries risks – and even a VPN endpoint that you deployed yourself, on hardware that you had physical control of, would have to be appropriately secured – being aware of the surrounding security landscape helps to mitigate this.



ABOVE All the VPNs on test include a kill switch to protect your privacy

Key features & obfuscation

We don't recommend and won't review any VPN that lacks a kill switch feature. This will stop all network traffic to and from your PC if the VPN drops. It's a vital way of ensuring that no data is accidentally sent via your standard internet connection. Note that this feature usually has to be manually enabled.

Split tunnelling allows you to exclude specific applications or IP ranges over a VPN connection and the rest via your usual internet connection. This is handy if you want to have access to other international and local streaming services or want to access content that requires a local IP address.

The most common form of split tunnelling is a tickbox allowing you to access devices on your local networking, but many VPNs, including ExpressVPN, NordVPN and Proton VPN, allow you to use whitelists and/or blacklists to include or exclude specific apps, URLs or IP ranges from your VPN connection.

Finally, there's obfuscation. If you're using a VPN to work around a national firewall in a country that bans the use of VPNs, such as the UAE, Russia, Turkey, Belarus or China, then a connection mode that hides the very fact that you're using a VPN is essential. It's also handy on a corporate network that deploys VPN detection. Techniques include removing packet headers that may identify VPN traffic, using SSL encryption or otherwise disguising VPN traffic as standard HTTPS traffic.

Testing video-streaming services

Turn to p94 and you'll see how we test the VPN services for speed. However, we also test video streaming performance, as many people explicitly want a VPN to watch overseas video content. This month, we tested videos exclusively available via iPlayer in the UK, Netflix in the US and Amazon Prime Video in the US. We've summarised those results on p95.

Netflix has continued its crackdown on VPN users, although its recent anti-account sharing measures didn't impact our ability to access its US services. When Netflix detects that a VPN is in use, it will typically only provide access to content that's local to the user. In some cases, Netflix US won't allow overseas accounts to log in when connected to a VPN, but you can get around this by logging in with it deactivated.

BBC iPlayer is wily. It both blocks access and sets a cookie to prevent further access from that browser even when you've disconnected from the VPN. Make sure you clear this between failed attempts.

Amazon Prime Video claims to restrict access to its US catalogue to even overseas Prime Video subscribers when they visit the US. However, we found that we were able to freely access films that were unavailable or only available to rent or buy in Europe from the US Amazon video portal with no difficulties at all. Note that the US video portal has a different URL to the EU and UK Prime Video portal (**amazon.com/gp/video/storefront**).

A WORD OF WARNING

Be careful about using a VPN permanently. There are times when hiding your location can work against you, such as when buying from UK stores online. Or when having a live chat with someone for support, and they think you're based in Norway (for example) rather than the UK.

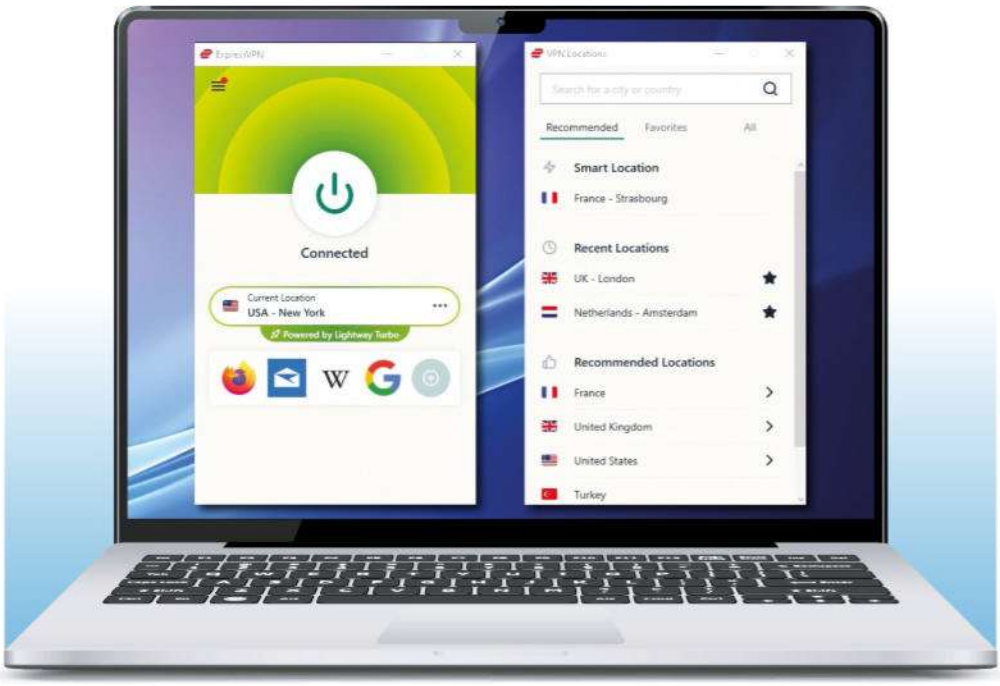
ExpressVPN

It's expensive, but you'll be hard-pressed to match ExpressVPN for features, performance or streaming

SCORE ★★★★★

BEST DEAL 2yr 4mth $140 (£113) from expressvpn.com

RENEWAL PRICE $100 (£81)



ExpressVPN is no stranger to winning *PC Pro* awards and takes away this year's accolade thanks to blistering speeds, outstanding region-shifting performance and a convincing track record on security. It's expensive but it's also worth it, although we recommend to committing to a longer subscription to reduce your monthly outgoings.

Let's talk speed first. The company recently launched new a version of its Lightway protocol, now developed in memory-safe Rust instead of C. This appears to have given its already fast transfer speeds a boost, as our test results saw it achieve a 499Mbits/sec average across its UK, Netherlands and US endpoints. That's the highest three-country result in the tests, with individual scores of 473Mbits/sec from the UK, 492Mbits/sec from the Netherlands and a remarkable 533Mbits/sec from the US.

While we saw faster results for the UK and Netherlands from VyprVPN and Proton VPN, ExpressVPN achieved the fastest US transfer speeds we've ever seen and – most importantly – was consistently fast across all the international endpoints we test. Moreover, it has been consistently fast across several years of tests.

ExpressVPN promotes its abilities to connect to streaming services undetected. This is great if you want an always-on VPN – for example, via your router – for privacy purposes, and don't want to be prevented from watching local streaming TV. From relevant endpoints, we enjoyed BBC iPlayer content in the UK and the latest shows from Netflix and Amazon Prime Video as if in the US. But don't buy it for this alone; NordVPN, PIA, Proton VPN, Surfshark, Windscribe and VyprVPN achieved a similar level of streaming effectiveness.

All that advanced technology costs money, and that's reflected in the pricing. ExpressVPN subscriptions cost $13 (£10.46) per month, $100 (£81) per year or $140 (£113) for two years, currently with four months extra. There are no hidden costs or price hikes upon renewal, but it's expensive compared to most other consumer VPN services, at least until your initial subscription discount on those rivals has run out. To sweeten the deal, ExpressVPN is giving away a 5GB travel eSIM, and you can also add a dedicated IP address to your account, if a fast, fixed, virtually local connection in another country is a priority for you.

However, most consumer VPN users prioritise anonymity, privacy, and the ability to quickly hop from one region to another. To support this, ExpressVPN is one of just a handful of providers to have rolled out post-quantum encryption, to protect against upcoming cryptography-breaking attacks on its tunnels. You also benefit from obfuscated servers designed to hide the fact that you're using a VPN, while RAMdisk servers can't retain even trace information between reboots.

ABOVE ExpressVPN is a feature-rich service with superb region-shifting abilities

BELOW Connection speeds were among the fastest we've seen

You can connect eight devices to ExpressVPN simultaneously. Like most serious VPN services, there are dedicated clients for Windows, Linux (including Raspberry Pi OS running on Arm64), macOS, Android and iOS. There are also instructions and connection profiles for other devices, so you can connect a wide range of routers, servers and smart appliances. ExpressVPN even produces its own range of VPN-focused routers, but they're currently only available in the USA.

ExpressVPN has had its share of controversies, conspicuously including a former board member, Daniel Gericke, who was found to have worked as a mercenary exposing journalists and activists who criticised the government of the United Arab Emirates. Gericke, who has now left ExpressVPN, agreed to cooperate with the FBI and was fined $335,000. The announcement of this coincided conveniently with the announcement that ExpressVPN had been acquired by Kape Technologies, the parent company of CyberGhost and Private Internet Access, also featured in this group test. Although Kape is based in the UK, ExpressVPN is still officially headquartered in the privacy-friendly territory of the British Virgin Islands.

While "board member cooperated with intelligence services after putting journalists in danger" isn't a great, feature for a VPN provider, it's by this point old news that we've covered several times here in *PC Pro*. The company has a generally robust approach to privacy, keeping no logs and doing a better job than most of the VPN industry when it comes to announcing and rectifying issues such as a 2024 split tunnelling bug on Windows that could have made user activity detectable in edge cases.

ExpressVPN has a solid track record on security – mostly under previous ownership, such as when a server was seized by Turkish authorities, who found no data. We'd like to see regular transparency reports, but the company's no-logging claims are convincing, and backed up by third-party audits. All of which means we feel confident enough in its abilities to make ExpressVPN our Labs winner.

Mullvad

This privacy-focused service isn't here to region-shift your video but offers consistent pricing and decent speeds

SCORE ★★★★★

BEST DEAL €5 (£4.34) per month from mullvad.net

RENEWAL PRICE €5 (£4.34) per month

Mullvad is, superficially at least, a no-frills service. It certainly has the simplest pricing scheme around: it costs €5 per month every month, for as long as you might want to subscribe. No discounts, no renewal fees, no limited-time-one-day-left-subscribe-NOW offers. You'll be charged in euros, and at the time we checked that worked out at £4.34 – that's the second most expensive price here, but remember that you only need to pay for this VPN when you need it.

Those who want extra privacy can pay using cryptocurrency, using a gift card or even by posting an envelope full of cash. The only negative to note here is that Mullvad recently reduced its money-back guarantee period to 14 days, the EU minimum; previously it was 30 days, which is more typical among VPN providers.

Although Mullvad is located in Sweden – not famed as a data privacy haven, although its law offers fairly robust privacy protections – Mullvad has committed to shutting down with immediate effect if it's forced into a position where it has to log or otherwise hand over user data. The company's principles were put to the test in 2023, when the company was raided but the police went away with nothing, as no data is stored. Mullvad also has its security and privacy policies audited on a regular basis.

Mullvad is one of a handful of VPN firms to introduce post-quantum encryption, designed to protect against the potential vulnerability of traditional encrypted tunnels to decryption by quantum computers. At the time of writing, it's up to version 2 of its own Defense Against AI-guided Traffic Analysis (DAITA) obfuscation tool. Developed with Tobias Pulls of Karlstad University, DAITA's defences help prevent your VPN-tunnelled data's patterns from being identified through machine-learning based analysis.

ABOVE Mullvad's strong privacy focus and simple pricing makes it a fine choice

And there's more interesting stuff elsewhere, including Mullvad Browser, its own remix of TorBrowser. Then there's the rollout of new obfuscation technologies such as ShadowSocks for WireGuard. It uses RAMdisk servers across its network, so no trace data can be retained between reboots. It no longer supports port forwarding for the benefit of torrent tracker users, though. If that's something you require, look into Windscribe, PIA or Proton VPN.

Clients are available for Windows, macOS, Linux, Android and iOS. Manual WireGuard and OpenVPN configuration files are also available, making it easy to connect servers, routers and other appliances. A browser plugin is available for Firefox. However you connect them, you can have up to five simultaneous connections to the VPN network. Since our last group test (*see issue 350*), Mullvad has upgraded its endpoint list to include 49 countries.

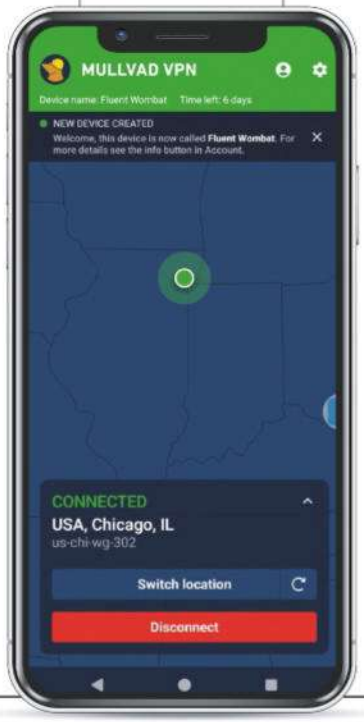
This emphasis on privacy and security, as well as upon keeping Mullvad's pricing accessible, means that Mullvad has a slightly different focus to most of the VPN providers in this group test. Conspicuously, it's not built for circumventing the geo-restrictions of streaming media services. We were actually able to watch Netflix and Amazon Prime US exclusives from US Mullvad's US endpoints during our most recent round of testing, but this isn't a core of focus of the company's mission, nor is it something you should necessarily expect. BBC iPlayer wasn't functional during the same batch of tests.

Mullvad's performance is also less consistent than its fastest rivals. We've seen it achieve blistering speeds in the past, but this time around it failed to beat the group test mean speeds. Still, this year's test performance was significantly fast than last year's, and we hope to see its improvement continue. It's fine for general use, but bear in mind that it's not great as a general-purpose speed-boosting tool for accessing internet services located in other countries.

If you genuinely need a consumer VPN for privacy, rather than because you want to watch that hot new region-exclusive TV show or to play video games with someone on the other side of the planet, then Mullvad is our first choice. Thanks to cash payment options (also available from Proton VPN), you can come very close to a truly anonymous service.

If you're after region-shifting prowess, however, Surfshark, Proton VPN and the wildly fast (but also rather expensive) ExpressVPN are all better for watching geo-locked content, as well as significantly faster than Mullvad. All three are also good prospects for privacy, but Mullvad's history and transparency means that we have a little more confidence in its service.

BELOW The service's endpoint list now covers 49 countries



Proton VPN Plus

This fast, feature-packed VPN is a strong choice for region-shifting, but it's no longer a rebel leader

SCORE ★★★★★

BEST DEAL 2yr, £72 (£86 inc VAT) from protonvpn.com

RENEWAL PRICE £60 (£72 inc VAT)

Once possessed of a rebellious image, Proton Technologies now takes itself seriously, with business tiers and lobbying interests. This has alienated some of its fans, but Proton VPN remains a fast and secure choice for a wide range of consumer VPN needs, from privacy to region-shifting. It's one of our favourite free VPN providers, too, although recent changes to its free tier mean you can no longer manually select your endpoint unless you're a paying customer.

Recently, some of Proton Technologies' choices have rubbed its more privacy-conscious users up the wrong way. It appeared to support a controversial US government pick in a post from an official account, although this was later walked back on as a personal opinion of CEO Andy Yen. Then it was criticised for rolling out an opt-in LLM-based writing assistant for its business customers, although even this can run on a local model for those who wish to keep everything on their PC. Perhaps most importantly, it caught flack for honouring Interpol warrants against climate activists using ProtonMail.

However, the firm is consistently clear about its legal position, both in terms of its obligations and the protections it can offer under Swiss law. It also actively fights battles in the Swiss courts to maintain the level of privacy that it currently offers its users. This means that, while not everyone – particularly privacy campaigners and activists – may find Proton Technologies to be as close an ideological fit as they might hope, the practical results of the company's structure and legal position under Swiss law mean that it remains a convincing proposal for your privacy.

Proton VPN specifically maintains a transparency document tracking the legal orders it has received, none of which it has fulfilled, even on the vanishingly rare occasions that an order has been honoured by the Swiss courts. They're rare as it keeps no logs, and this no-logging policy has also been independently audited.

During the course of our review, Proton VPN's client application was updated to a new version, with a more rounded, less boxy aesthetic, soft colour gradients and a helpful range of shortcut buttons to core settings. These include the kill switch, activating NetShield for malware and phishing defence, plus split tunnelling – this allows you to exclude specific applications and IP addresses from your VPN – and port forwarding.

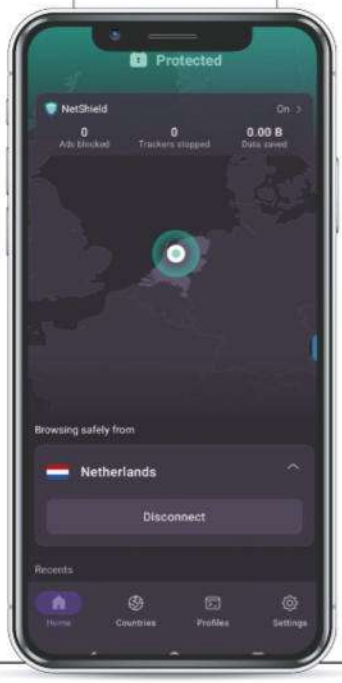
Port forwarding is a rare feature; in this month's group, only ExpressVPN, PIA and Windscribe support it. It means you can use peer-to-peer (P2P) trackers to improve performance of BitTorrent downloads. This is reflected in the extra quick connection profiles Proton has added, with P2P profiles now on offer alongside streaming, security, gaming and the previously available random and fastest options.

The free tier once allowed you to choose between endpoint servers in the USA, Netherlands and Japan. Now, free users are given access to five different countries but can't choose which one they're connected to. This reduces contention and spreads the load more evenly among the 2,300+ endpoint servers made available to free users, but means free users no longer get even the limited degree of region-hopping previously available. So now you need to pay if you want guaranteed access to international streaming services. There's a custom endpoint aimed at US streaming, which worked well, but we had to switch between a few different UK endpoints to gain access to BBC iPlayer.

ABOVE Proton is an extremely fast VPN that offers plenty of bang for your buck

PC PRO RECOMMENDED

BELOW You'll need to pay to guarantee access to foreign streaming services



The service is one of the best in terms of performance. Sure, its three-country speed test average wasn't quite as fast as that of ExpressVPN, following major upgrades to the latter's protocols and infrastructure, but it comes close. It also gave us the highest transfer speeds, right up to 598Mbits/sec, consistently improving on our reference speeds without a VPN.

You do pay for this infrastructure. Proton automatically converts its euro price into pounds when you purchase so the exact price will vary, but annual renewals cost around £65 (€80), while Proton tempts new users with its two-year deal for around £86 (€108). That works out at £3.58 per month over the course of the contract. None of these prices is cheap, but they're respectable in the current VPN landscape and you certainly get a lot of bang for your buck. If you need extra anonymity, you can pay for your subscription using cryptocurrency or cash.

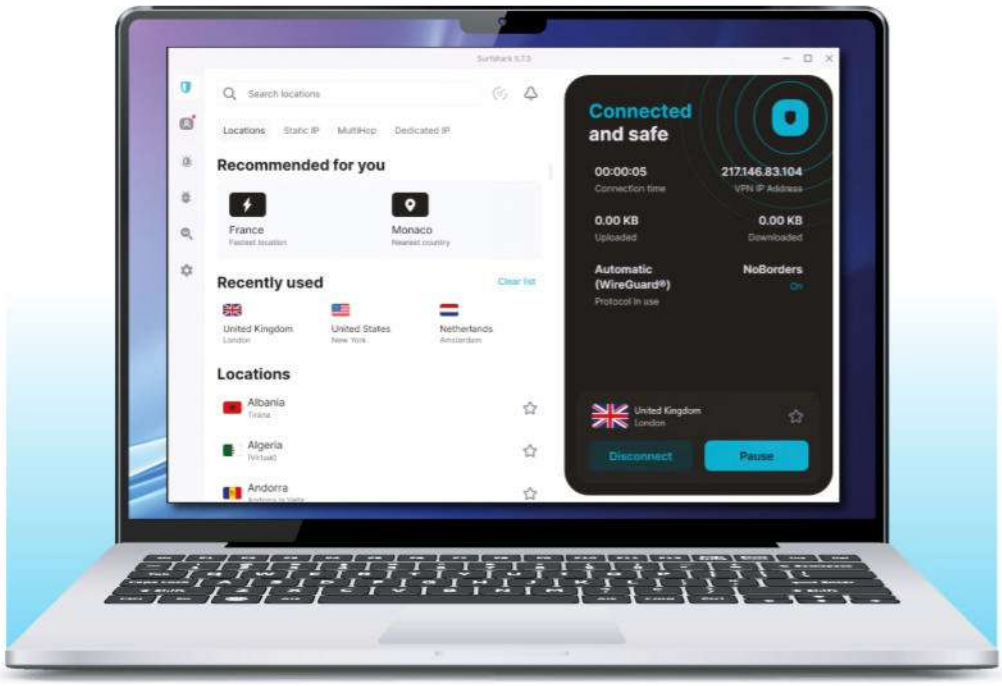
Perhaps a better deal, if you need all the services in question, is a Proton Unlimited subscription, which costs around £100 per year (£160 if you commit to two years) and includes a VPN, encrypted email and secure storage. If you're just after a hyper-fast VPN, ExpressVPN is the way to go, while Surfshark is also strongly competitive in terms of performance and costs a little less. Nonetheless, Proton VPN is easy to recommend on its technical merits.

Surfshark

Fast, cheap and great for streaming, Surfshark remains one of our favourite VPN services

SCORE ★★★★★

BEST DEAL Starter, 2yr 3mth £40 (£48 inc VAT) from surfshark.com
RENEWAL PRICE £59 (£71 inc VAT)



Like its sibling company NordVPN, reviewed on p90, Surfshark is rapidly moving into traditional internet security spaces. It now offers features such as remote and local malware scanning and protection for PCs, removal of your personal information from data brokers, eSIMs and single-use alternative identities. These are available in a variety of different bundles, but this Labs focuses on straight-up VPN services so we've reviewed the Surfshark Starter package. This doesn't include any of these extras, unless you count the travel eSIM sign-up bonus, but it's extremely cost-effective if all you need is a VPN.

Surfshark is the consumer VPN service we most frequently recommend, thanks to dependable and fast performance in our tests, year in, year out. It's also routinely excellent for watching all kinds of region-locked media: it sailed through our current iPlayer, Netflix and Amazon Prime tests, but then it usually does. Although ExpressVPN and Proton VPN were both faster in our most recent tests, Surfshark never fell below 300Mbits/sec so it's a match for anything you want to throw at it, from streaming to gaming.

Irritatingly, all tiers of the service cost more than you might initially expect from visiting its site, as Surfshark doesn't list VAT up front. Unless you're buying for business use, you'll pay 20% on top. If you pay monthly, you'll pay a stiff £14.75 including VAT, but most people will opt for the fantastic two-year deal (with an extra three months free) for £48. As is often the case with VPN providers, Surfshark varies its deals so it can have "limited time deals" at the top of its site, urging you to buy now, but it should be around this mark when you order.

Unless you cancel your subscription, the service will renew at whatever price $79 plus VAT converts into. At time of writing, that's around £70 including VAT, so it's best avoided. There's no free trial, but you do get a 30-day money-back guarantee. Those in search of additional privacy can pay using cryptocurrency, although we'd like to see a cash payment option to rival those offered by Mullvad and Proton VPN.

The company also engages in activism and education surrounding online privacy. And it runs a free account scheme for activists and journalists in parts of the world where online security and obfuscation can be essential not only to their work, but also their liberty and lives.

At one point Surfshark was headquartered in the British Virgin Islands, a popular location for VPN providers as it doesn't require logs to be kept, participate in international intelligence sharing agreements or otherwise be subject to data seizure. But the company, which has functionally been run from Lithuania since its inception, is now legally headquartered in the Netherlands, which is subject to EU law and data-gathering agreements but isn't particularly grabby when it comes to logging requirements for VPNs.

And that's the key point: if no logs are kept, they can't be handed over. That's why you want a VPN with a proven track record of not keeping logs. While Surfshark has never had hardware seized or been dragged into court – practical ways of revealing whether a company puts its money where its mouth is regarding logs – it does maintain a warrant canary, which will be changed or removed if it's ever subject to a gagged US court order. It also commissions external audits (from Deloitte and Cure53) of its security and logging policies.

Surfshark has a comprehensive range of features, including RAMdisk servers, a variety of obfuscation technologies and split tunnelling in the form of a cross-platform Bypasser feature. There are also multi-hop servers and optional fixed IP addresses in other countries. You can simultaneously connect an unlimited number of devices, but within reason. If you try running a server farm with dozens of simultaneous VPN connections via a single account, you're going to be told to knock it off and potentially have your account terminated without further warning.

With endpoints in over 100 countries, Surfshark is one of the most geographically comprehensive choices if you need to virtually "be" in a lot of different places. Useful to ensure that a given website works correctly internationally.

All of which means that Surfshark is one of your best choices if you're looking for a consumer VPN. Even though its prices including VAT aren't always immediately apparently, it's actually one of the cheapest options around if you choose its two-year subscription offer.

ABOVE Surfshark is fast and always dependable in our tests

PC PRO RECOMMENDED

BELOW Endpoints in over 100 countries make it an excellent choice for streaming

Avast SecureLine VPN

Use it if bundled with your antivirus, but too slow and limited to be worth a standalone subscription

SCORE ★★☆☆☆

BEST DEAL 3yr £93 (£112 inc VAT) from avast.com

RENEWAL PRICE £67 (£80 inc VAT)

Avast, the free and paid-for antivirus brand of worldwide renown, is part of the Gen Digital group, which now also owns the Avira, AVG and Norton brands. We've also reviewed Norton's VPN on p90, which uses a different infrastructure (as does Avira Phantom VPN), but it would have been pointless to review AVG Secure VPN as it's exactly the same product as Avast SecureLine except with different branding on the client.

Its features are limited. For example, it's one of only two services here that don't provide a Linux client, nor does it offer profiles for use with routers, services and other appliances. However, if all you care about is clients for Windows, macOS, Android and iOS, plus plugins for Firefox and Chrome, then it ticks those boxes. Your subscription also covers ten simultaneous connections.

SecureLine uses the OpenVPN and WireGuard protocols, but it also offers Mimic, a proprietary obfuscation protocol that aims to hide the fact that you're using a VPN in the first place. It doesn't offer sophisticated features such as post-quantum encryption, and there isn't a robust commitment to privacy – merely the promise that logs of your activity won't be kept.

ABOVE SecureLine VPN is slow and lacks advanced features

We saw speeds as slow at 21Mbits/sec during our tests – ten time slower than the group average this month – and none faster than 70Mbits/sec. While that range of speeds is fine for a single stream of video, it won't support the heavy traffic demands of demanding users. On the subject of streaming, SecureLine failed most of our tests in which we attempted to connect to video streaming services while using the VPN – only Netflix US worked, while BBC iPlayer and Amazon Prime in the US were unavailable.

Despite these limitations, a standalone subscription isn't cheap. You'll pay £40 per year, £85 for two years or £112 for three years. All subscriptions renew at £80 per year.

If your Avast antivirus subscription service includes SecureLine and your requirements for a VPN are modest and fairly infrequent, then it's a perfectly good choice. But if speed, performance or value for money are concerns – and when are they not? – you should look elsewhere.

CyberGhost

A mid-tier VPN that struggles to stand out for price, performance or video-streaming skills

SCORE ★★★☆☆

BEST DEAL 2yr 4mth £50 (£60 inc VAT) from cyberghostvpn.com

RENEWAL PRICE £50 (£60 inc VAT)

CyberGhost is a long-established consumer VPN service. It's a subsidiary of Kape Technologies, which also owns ExpressVPN and Private Internet Access, among others. Like its siblings, CyberGhost operates autonomously; while Kape is based in the UK, CyberGhost is headquartered in Romania.

CyberGhost operates endpoints in 100 countries and gives you seven simultaneous connections. Client apps are available for Windows, macOS, Linux, Android and iOS, with profiles for using the service with routers, smart TVs and other appliances, plus Firefox and Chrome plugins. CyberGhost's clients variously use WireGuard, OpenVPN and IKEv2. Like many VPN firms, the company dropped support for L2TP/IPSec due to potential edge-case vulnerabilities in 2020.

Despite reasonably fast UK transfer speeds of 275Mbits/sec, CyberGhost was unimpressive in our tests, with Netherlands and US speeds less than half the group average. You'll be able to do everything you need, but it won't win any races. Although CyberGhost promotes itself as an ideal service for region-shifting to watch geo-locked streaming content, it didn't sweep the board in our streaming tests. We were able to watch BBC iPlayer from UK endpoints and Amazon Prime Video in the US, but Netflix US resisted our efforts to watch movies while securely connected to a US VPN endpoint.

ABOVE CyberGhost's fully functional trial lets you try it for free

CyberGhost costs £13.07 a month, £37 for six months or £60 for two years – currently available with an extra four months free. The two-year-plus-four-months subscription works out to be incredibly good value, but forget to cancel in 2027 and you'll pay its standard renewal price of £60 per year, which is on the expensive side. We've added VAT to our calculations, so our listed prices are higher than those displayed on CyberGhost's website.

Unusually, CyberGhost has a fully functional free trial, which – for Windows and macOS users – doesn't even require you to supply your credit card details. Just download the desktop client and you'll get 24 hours of access to all 100 of CyberGhost's endpoints. Note that trials on mobile platforms will be linked to your Android or iOS account and associated payment cards, and will be automatically billed at the end of the trial period. Cryptocurrency payments are also supported, but like so much else about CyberGhost that doesn't make it special.

Best free VPNs

If you don't want to spend a penny on a VPN then you have plenty of options, but be careful to avoid those that want to harvest your data

Finding a good free VPN can be a minefield. Fortunately, most of those mines are visible. As a rule of thumb, avoid whatever floats to the top of VPN search results on your phone's app store. While they include reputable services such as those reviewed here, you can also encounter malware or apps that primarily exist to harvest data for app-ranking services such as Sensor Tower (owner of Luna VPN) and App Annie (owner of Phone Guardian VPN).

So our recommendations for free VPNs are taken from the same pool of well-established, privacy-conscious providers as our paid-for VPN recommendations. Three of the VPNs we've reviewed this month have free tiers, while CyberGhost provides a free trial. Each requires you to create an account before you can access the service, but all you'll need for this is an email address – there's no requirement to hand over any payment data or other personal information.

We've tested each of these services' free tiers, rather than simply reusing data from our paid-for reviews. That's because the free user experience in most cases differs from what paid users get. We'll explain those key differences below, but generally you won't get access to extra features such as manual configuration profiles, servers optimised for video and the ability to connect multiple devices.

ABOVE **There are lots of dodgy free VPNs out there, so ensure you choose wisely**

Proton VPN

Our favourite free VPN is also one of our favourite paid-for VPNs, and that's because it still performs well in terms of speed, security and features. It's available for all the usual desktop and mobile platforms and – unlike other free VPNs here – doesn't limit your available bandwidth.

Until recently, free users could manually select from three endpoint countries, but now you don't get a choice. A wider range of endpoints are available, in Japan, Poland, the Netherlands, Romania and the US. Because it always opts for the fastest available endpoint, Proton VPN Free actually gave us faster test results than its paid-for counterpart in a couple of our tests, with speeds of up to 598Mbits/sec when we connected to our Dutch reference server from an endpoint in the Netherlands.

Our favourite free VPN is also one of our favourite paid-for VPNs, and that's because it still performs well in terms of speed, security and features

BELOW **Free versions differ from paid-for VPNs in many ways**

If you use only one free VPN and your primary requirement is privacy, Proton VPN is the one to go for.

Windscribe

With ten endpoints for free users and 10GB of bandwidth if you're happy to attach an email address (dropping to 2GB if not), Windscribe's free tier is a useful addition to your VPN arsenal. Especially as 10GB is fine for accessing geo-locked news websites.

Free users get access to endpoints in the US, Canada, UK, Hong Kong, France, Germany, Netherlands, Switzerland, Norway, Romania and Turkey, so you have genuine options for locating yourself in a specific country. You might prefer that rather than Proton VPN's approach, which emphasises performance.

And speed is not an issue. We consistently found that the free service performed better than our lifetime subscription to Windscribe, with transfer speeds of 172Mbits/sec in the UK, 119Mbits/sec in the Netherlands and 104Mbits/sec in the US.

TunnelBear

TunnelBear's free tier is great, but 2GB of data simply doesn't go that far on the modern web, even if you're simply accessing standard websites, such as the surprising number of US websites that block UK and EU users because they don't wish to adhere to the requirements of GDPR.

The performance of TunnelBear's free service is in line with its paid-for service, while its bandwidth meter appears to be rather generous in terms of how much data you can actually transfer, but we'd still lean towards Windscribe or Proton VPN.

CyberGhost

It's not a free VPN, but you can use CyberGhost's service completely free for 24 hours, with no obligation to hand over your credit card information. On Windows or macOS, simply download CyberGhost's desktop app, create an account when prompted and you'll have 24 hours to try out the service. You get access to 100 VPN endpoints, no speed restrictions or bandwidth cap, and all the features of the desktop apps.

Other free thinkers

While it's generally understood that you don't get something for nothing, a number of other reasonably well-regarded VPN firms have free offerings. These are either part of their efforts to make online privacy more accessible, or simply a way to get people to make accounts, see how great their service is, and – they hope – upgrade to a paid tier.

In alphabetical order, examples include Avira Phantom VPN (capped at 500MB per month), OkayFreedom VPN (250MB), PrivadoVPN (a generous 10GB) and Trust.Zone (1GB).

NordVPN

Remains a contender but pricing is obscure and the renewal cost excessive, and falls behind rivals for speed

SCORE ★★★★☆

BEST DEAL Basic, 2yr 3mth £65 (£77 inc VAT) from nordvpn.com
RENEWAL PRICE Basic, £117 (£140 inc VAT)

NordVPN was once known for obnoxious brash advertising, but the Latvian firm has grown up into an online security service provider with a more sober image. Nord Security services for consumers also include the NordPass password manager and NordLocker encrypted cloud storage, while the company provides a range of business services as well. It has its services regularly audited, convincingly addressed a breach and subsequently improved its customer communications.

You can subscribe to NordVPN as part of a bundle with NordPass and NordLocker, which might be worth a look if you need secure cloud storage. But forget about NordPass: it won't be our favourite password manager as long as KeePass and Bitwarden exist.

NordVPN's pricing is somewhat obscure. To its credit, the company publishes a list of its default annual pricing in various regions and makes clear that prices go up to this upon the renewal of your subscription, but that doesn't make up for obfuscation elsewhere. For instance, the prices plastered across the front of the NordVPN website all exclude VAT.

ABOVE NordVPN offers endpoints in 118 countries

Including VAT, the cost of the company's Basic VPN package works out at £11.99 per month, £56 for your first annual subscription, or £77 for an initial 27-month subscription. However, both the one- and two-year deals renew at the standard annual rate, which is currently a whopping £140. We applaud the fact you can subscribe using cryptocurrency if want anonymity, but still.

In NordVPN's defence, it's dripping in features. It supports the latest standards and technologies, from RAMdisk servers to post-quantum encryption and obfuscation, while you can choose from endpoints in 118 different countries and territories – more than any other service in this group test. It's also incredibly consistent when it comes to letting you watch streaming TV while connected to the VPN.

Its performance in our speed tests was well above average – not chart-topping, but easily quick enough for the highest-resolution streaming, gaming with friends across the world and other bandwidth-intensive tasks.

There's no award for NordVPN this month, largely due to its pricing choices and rivals pushing their speeds to new heights, but it's still a great long-term choice for your privacy and region-shifting needs.

Norton VPN

There are no reasons to choose this service over the opposition, but it's a worthy extra in Norton 360

SCORE ★★☆☆☆

BEST DEAL Standard, 1yr £17 (£20 inc VAT) from uk.norton.com
RENEWAL PRICE Standard, £34 (£40 inc VAT)

Norton VPN – previously Norton Secure VPN – is most regularly found as part of Norton 360, a comprehensive suite of consumer antivirus and internet security tools, which earned four stars in our last antivirus group test. However, you can also subscribe to Norton VPN as a standalone service.

If you only need one connection to be active on a single device at a time, Norton's Standard subscription is the lowest around. It costs £20 for the first year, which works out at £1.67 per month. However, there are two big caveats. First, hardly anyone's VPN use looks like that, particularly as Norton doesn't provide profiles that you can use on your router. Second, it renews at £40 per year, and £3.33 per month is far less competitive.

Many people will want more than one device protected at any one time, at which point they need to upgrade to Norton VPN Plus. This covers five devices for a first-year cost of £25, rising to £80 (not a typo). Here you wander into antivirus protection, so beyond the scope of this test (although Norton generally performs well here), plus 10GB of cloud backup. If you want protection against ten devices you'll need to pay £30 for VPN Ultimate, which gives you 50GB of cloud backup and family safety extras, but the sting comes in a year when it renews at £95.

ABOVE Norton VPN is often bundled with the Norton 360 suite

Back to VPNs. Although Norton, a Gen Digital subsidiary, is a sibling company of Avast, the two services don't share their infrastructure. Norton Secure VPN was the better performer this month, but still well below the group test average. We've tested VPNs over many years, and Norton is inconsistent, often putting in a more impressive performance.

Norton VPN supports streaming while connected to the service, and we had no trouble accessing US Netflix and Amazon Prime. Watching BBC iPlayer while connected, however, was a non-starter despite several attempts.

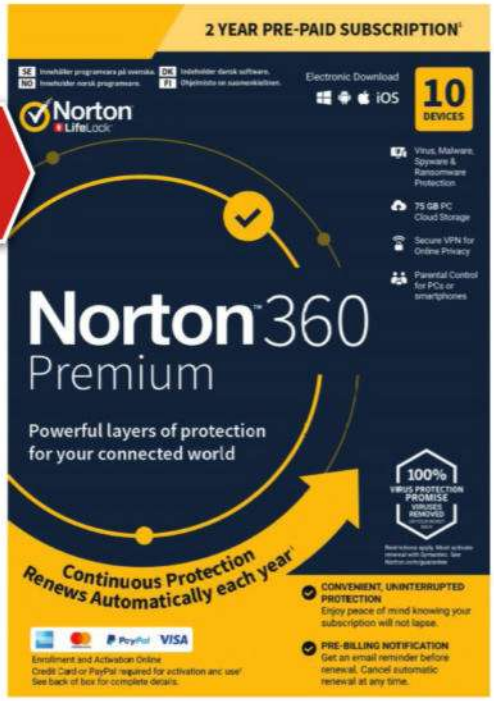
Norton VPN has a cheap single-device introductory offer, but the service lacks features – it doesn't even offer any obfuscation options to hide the fact that you're using a VPN, and it only supports Windows, macOS, Android and iOS, exclusively through its own clients. To avoid the costly renewals, we recommend you buy Norton 360 directly through third-party retailers – including the *PC Pro* store (**store.pcpro.co.uk**), where a ten-device, two-year subscription to Norton 360 Premium costs £20.

Bag a software bargain

Don't pay full price for software when we can offer you huge reductions on genuine products

NORTON 360 DELUXE for £14.99

SAVE 90%



3 DEVICES | **2YR LICENCE**

tinyurl.com/nortondeluxe2025

We've negotiated this exclusive deal for *PC Pro* readers. No subscriptions, just a one-off bargain price of £14.99 compared to the regular £149.99 charge. That buys you two years of cover from the powerful Norton Security suite across three devices, and there's no danger of being hit with hiked renewal fees.

Because it's the Deluxe version of Norton 360, you get a host of extra tools. Top of the list is the full version of Norton VPN, both to protect your identity and provide a way of watching British TV while you're abroad.

There's also 25GB of cloud storage for secure backup, while Norton's Dark Web Monitoring service will alert you if private details – such as your email address and passwords – have been compromised online.

Norton Parental Control provides tools to see exactly what your kids are up to on their various devices, and you also get GPS location monitoring for Android and iOS.

To round things off, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals attempting to take photos with your webcam without your knowledge.

WINDOWS 11 PRO UPGRADE for £49.99

SAVE 58%

1 PC | **PERPETUAL LICENCE**

tinyurl.com/win11pro-upgrade

Want to upgrade from Windows 11 Home to Windows 11 Pro? Or perhaps you're looking to move up from Windows 10 Home?

Whatever your motives, a Windows 11 Pro upgrade licence is a great choice. Microsoft charges £119.99 for a retail licence of Windows 11 Home, £219.99 for Windows 11 Pro, and £119.99 for its own upgrade licence from 11 Home to Pro.

Unlike Windows 11 Home, Windows 11 Pro enables you to connect to a business domain. It also provides BitLocker to encrypt whole drives. Best of all, you can create and host virtual machines using Hyper-V, which is ideal for testing new software or, if you're a developer, seeing how your software performs on a fresh OS.

Note that the upgrade only works from an activated copy of Windows 11 Home, so if you're using Windows 10 Home then you'll need to upgrade to Windows 11 first. Want to upgrade from Windows 7 or 8? Or building a PC from scratch? Head to **tinyurl.com/windowspro11** and grab a full 1-PC licence for Windows 11 Pro for only £79.99.

CCLEANER 6 PROFESSIONAL for £10

SAVE 75%

1 PCs | **1YR LICENCE**

tinyurl.com/ccleaner6pro

When it comes to PC optimisers, we can think of only one brand that has a consistent reputation for delivering results: CCleaner. This is the professional version, so as you would expect it comes with a bunch of extra tools compared to the free edition.

First up is the new Cloud Driver Cleaner. This scans Google Drive for duplicates, large files and old versions, so you can quickly reclaim space. You also benefit from our old friend Performance Optimizer, with CCleaner promising up to 34% more speed and 30% more battery life.

Despite improvements in Windows' own tools, we remain fans of third-party apps such as Driver Updater to keep track of updates – often solving problems such as bugs and unexplained crashes long before Microsoft. Likewise Software Updater, which can close security holes before they come to your notice.

Add priority support, real-time monitoring and scheduled cleaning, and you're getting an awful lot for your £10 investment. And whereas a one-year licence costs £39.95 when bought directly from the CCleaner website, we're offering it at a massive 75% discount.

Private Internet Access

An inexpensive consumer VPN with plenty of features but consistently poor transfer speeds

SCORE ★★★☆☆

BEST DEAL 3yr 4mth, £54 (£65 inc VAT) from privateinternetaccess.com
RENEWAL PRICE 3yr £54 (£65 inc VAT)

At one time, Private Internet Access represented the gold standard for speed and proven security in the world of consumer VPNs, founded with an express mission of making privacy more generally accessible.

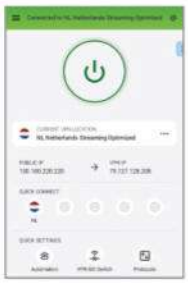
It's now a mid-tier player – its network infrastructure and consequently its transfer speeds haven't seen the kinds of dramatic upgrades invested in by others, such as sibling company ExpressVPN and rivals Surfshark and Proton VPN.

It was bought by VPN mega-player Kape Technologies in 2019, and infrastructure aside the company has been run independently and effectively since. Upgrades include support for the WireGuard protocol and unlimited (within reason) simultaneous connections, as well as standard features such as split tunnelling and DNS leak protection.

PIA doesn't publish transparency reports or a warrant canary to alert users of a gagged data seizure by US authorities but has committed to shut down any servers if it's unable to maintain them securely. What's more, the company has historically and demonstrably protected users in the face of court orders by dint of its robust no-logging policy, all backed up by regular third-party security audits.

PIA's prices are extremely reasonable and hikes reasonable, but it's very clear that the company wants you to commit to three years at a time. It makes no sense to pay £9.99 on a monthly basis, while if you choose the single-year option you'll pay £32 for the first year and £41 the next. Choose three years and it's £65 every three years without hidden price hikes, and PIA sweetens the deal with four months free for the first sign-up. That works out to an outstanding £1.63 per month; the cheapest "monthly" fee in this entire group test. There's also a 30-day money-back guarantee, and the option of paying using cryptocurrency or gift cards.

ABOVE Sadly, PIA's performance was poor in our tests



The problem is that PIA's performance is poor. It put in the worst performance of any service in this group test, with particularly slow throughput between continents. Better news: PIA's apps are stable and have plenty of features, and they allowed us to watch geo-locked TV in the form of BBC iPlayer in the UK and Netflix and Amazon Prime in the US.

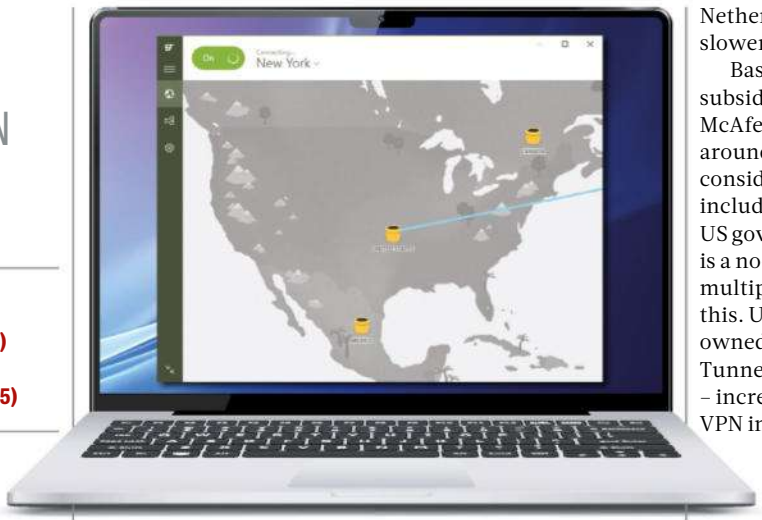
We'd choose Surfshark over PIA as its longest subscription works out almost as cheap.

TunnelBear

Reliable and reasonably quick, this Canadian VPN maintains clear and consistent pricing

SCORE ★★★★☆

BEST DEAL Unlimited, 3yr $120 (£90) from tunnelbear.com
RENEWAL PRICE Unlimited, $60 (£45)



TunnelBear is one of a handful of truly reliable free VPN providers. Free users get 2GB of data and access to the service's full range of endpoint locations, which makes it particularly worth having if you need to access online content from a specific part of the world. That's even more true now that Windscribe's free service only lets you choose from ten endpoint locations, while Proton VPN's unlimited bandwidth free VPN no longer allows you to choose your endpoint location at all.

If you're happy to put your hand in your pocket for trips abroad, say, it will cost $10 (around £7.50) per month, which is one of the better choices out there for occasional use. Annually, it costs $60 (around £45), which is also the renewal cost. But the best deal is to sign up for three years for $120, which is roughly £90 or £2.50 per month.

Both free and paid-for endpoints performed well in tests, but we saw rather faster speeds on our paid account. The paid account's speeds were around the mean average, and provided a speed boost for transatlantic file transfers compared to speeds without a VPN. Free speeds are a little below average: faster for the US and Netherlands than Windscribe, but slower than Proton VPN Free.

ABOVE TunnelBear is a very competitively priced VPN service

Based in Canada, the company is a subsidiary of US antivirus giant McAfee. This raises some questions around jurisdiction, which are worth considering if your privacy concerns include potential surveillance by the US government. However, TunnelBear is a no-logs VPN and has undertaken multiple third-party audits to confirm this. Unusually for a VPN service owned by a major security firm, TunnelBear both offers a Linux client – increasingly expected across the VPN industry – and downloadable profiles for use with routers and other appliances.

Although TunnelBear hasn't always prioritised the ability to watch geo-locked streaming TV, it now supports region-shifting for streaming services. That means you don't need to disconnect the VPN or use split tunnelling to watch Netflix, for example. However, although TunnelBear usually works for the UK's national broadcaster, we were unable to watch BBC iPlayer from UK endpoints this time around. US versions of Netflix and Amazon Prime presented no problems, however.

So, while not quite an award-winner, TunnelBear is a great choice whether free or paid-for.

VyprVPN

Note its new USA HQ, but VyprVPN is still a decent service despite inconsistent speeds in our tests

SCORE ★★★☆☆

BEST DEAL 2yr, £60 (£72 inc VAT) from vyprvpn.com

RENEWAL PRICE 2yr, £60 (£72 inc VAT)

VyprVPN is a long-established provider that recently changed ownership. That always brings question marks. While it has a strong track record of keeping no logs, and was among the first VPN providers to commission a third-party audit, until we see new audits and evidence to back up Vypr's no-logging status this remains an unproven factor.

One thing hasn't changed: if you require access to Usenet, you still get a full VyprVPN subscription with every annual subscription to the company's sister Usenet provider, GigaNews. That makes sense as both companies recently transferred hands from Golden Frog into the hands of Certida (we're aware that frogs don't have hands). Golden Frog was legally based in Switzerland despite its physical operations being based in Texas; Certida, however, is both legally and physically based in that state.

Switzerland is generally regarded as a safe location in legislative terms, with more robust protections against data gathering and a requirement to notify customers that are subject to investigation, so this can be regarded as a downgrade. However, we review other VPNs with links to the US, most notably Private Internet Access, and if no logs are kept, then court orders aren't a problem. However, we'd be a lot happier with this new legislative position in an increasingly privacy-hostile country if VyprVPN maintained a warrant canary.

VyprVPN is blisteringly fast if you stick to endpoints on the same continent, but we noticed a significant dip when it came to transatlantic file transfers. By no means catastrophic, but others are more consistent.

It's a great choice if you need to stay connected to your VPN while watching streams or for region-shifting. We were able to stream content from iPlayer, Netflix and Amazon Prime without any issues.

VyprVPN doesn't have support for quantum encryption, nor does it have RAMdisk servers, but it covers all the core features and protocols we expect from a VPN. And we also applaud the fact its fees are both straightforward – no hidden renewal fees – and reasonably priced. A single month costs £9, a year cost £54 and signing up for two years costs £72. Whichever contract you sign up to will renew at that same fee. The two-year deal translates to £3 per month, which covers five simultaneous devices, so it's solid value, albeit a no-frills choice.

ABOVE VyprVPN is a great choice for region-shifting

Windscribe

A superb free offering that can be supplemented by tactical monthly purchases make this a strong choice

SCORE ★★★★☆

BEST DEAL $69 (£52) from windscribe.com

RENEWAL PRICE $69 (£52)

Windscribe is a stalwart of the VPN world, and it has a great track record for calling out deceptive behaviour in the industry. For example, it has called out the practice of companies buying out both VPN providers and review sites. It also keeps on top of developments in VPN technology, from RAMdisk servers to quantum safe encryption.

It's perhaps best known for its generous free tier, which gives you 10GB of data throughput every month via ten endpoints around the world. We tested its performance across both a free account and our legacy lifetime paid-for account, and actually saw better results from the free endpoints. While it wins no speed awards, all the results are adequate for everything from downloads to multiplayer gaming to streaming. No matter where you are, you should have no trouble with the latter: Windscribe allowed us to view region-locked content from iPlayer, Netflix and Amazon Prime.

Windscribe's paid-for service is reasonably good value, and benefits from clear, simple and consistent pricing. The company at one point offered lifetime subscriptions – we use one for our reviews – but no longer. In fact, the longest subscription you can buy is one year, which costs $69, so around £52. While that's nowhere near as expensive as ExpressVPN, it's higher than many of its faster rivals at around £4.50 per month.

Perhaps where it makes more sense is for the occasional VPN user, with a one-month subscription costing $9 (a shade under £7 at current rates). That makes it one of the best streaming-optimised examples you'll find, although look at Mullvad if that isn't part of your requirements. If you're looking for extra privacy you can pay using cryptocurrency, but not gift cards.

Windscribe maintains a transparency document, has its security and no-logging policies regularly audited and has open-sourced its client software. When its Ukrainian endpoint server was seized by police and revealed to be insecure, Windscribe was open about the incident and detailed future security improvements which it then delivered upon.

The service isn't especially fast, especially for intercontinental transfers, but Windscribe's consistent pricing, visible commitment to privacy and regular tech upgrades make it a reliable choice.

ABOVE Windscribe's free offering is among the best you can get

How we test

Every VPN is put through a rigorous series of performance tests

We carry out tests on a Windows 10 desktop virtual machine hosted on a server with a symmetric gigabit fibre link. Using endpoints in the UK, Netherlands and USA, we download content from reference servers physically located in London, Amsterdam and New York. We do this via HTTP using curl at the Windows command line.

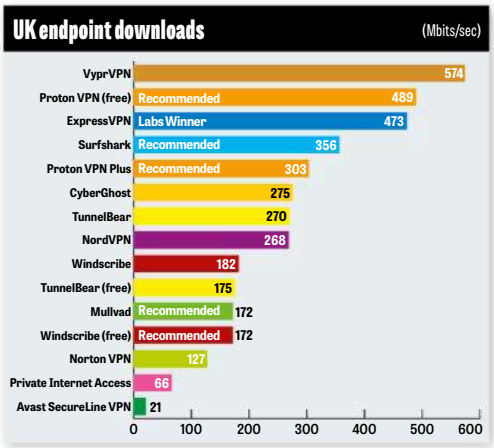
We download around 600MB of data to allow us to observe variations in download speeds over time. At the time of testing, our virtual machine's reference connection speeds were a speedy 314Mbits/sec to our UK target, 484Mbits/sec to the Netherlands and 68Mbits/sec to the USA. These reflect internet conditions at the time of testing and were borne out by the performance of most of the VPNs.

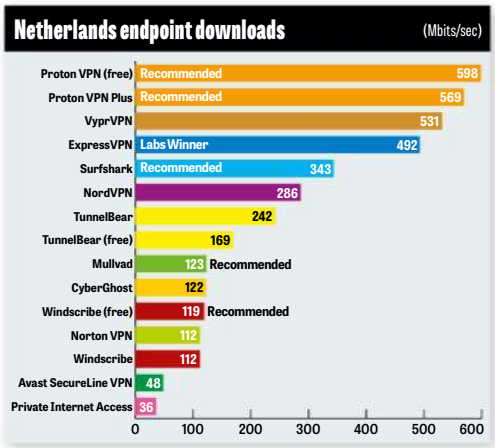
Some VPNs were able to significantly improve on our un-VPNed speeds, illustrating another potential advantage of using a VPN: faster connection speeds by using the VPN provider's efficient international network routing infrastructure.

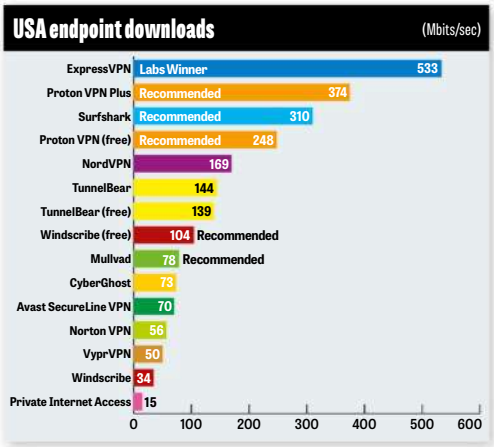
For example, we saw connection speeds of up to 598Mbits/sec via Proton VPN's Netherlands endpoint, which is reliably our fastest connection, year after year. Those on slower internet connections can also benefit from improved download speeds, particularly to remote locations such as the US: the fasted VPNed US speed was 533Mbits/sec, compared to only 68Mbits/sec without.

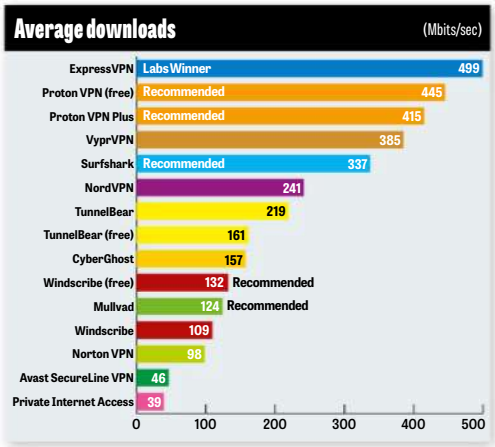
The disadvantage of using download speed as a proxy for overall performance is that it only provides a snapshot of a single metric at a single point in time. We re-test unusually fast or slow results. We also rely on several years' worth of historic test data for a variety of popular VPN services to provide a long-term performance reference. All the data is publicly available at **vpndatatracker.com** for transparency purposes. We take historic performance into account in our overall ratings.

Speed tests

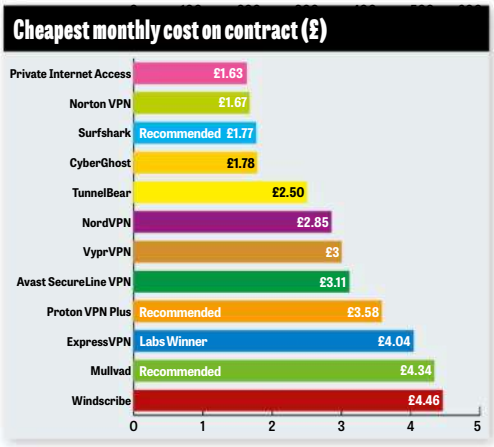


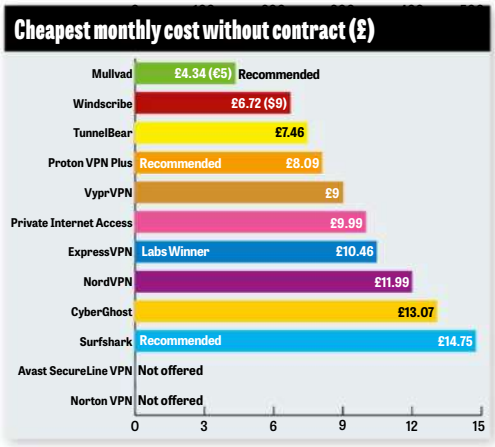


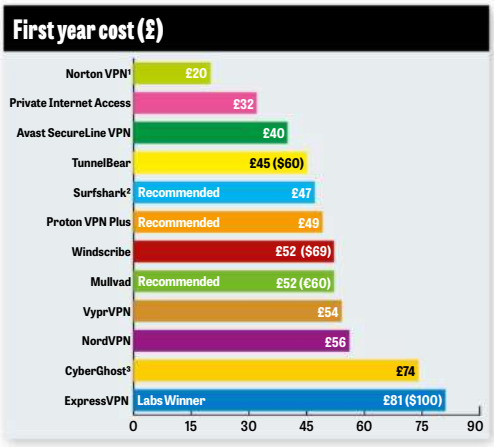


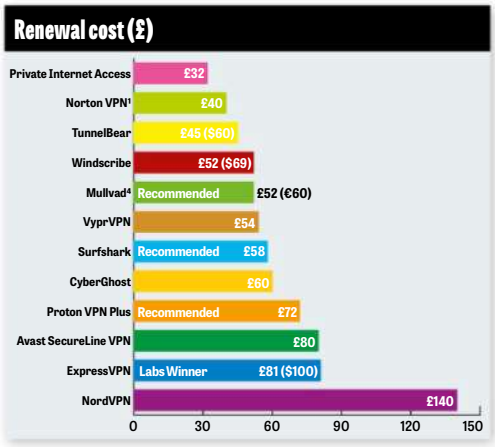


Cost comparison









[1] Only includes one concurrent connection. [2] Includes three extra months. [3] Two six-month subscriptions. [4] 12 monthly subscriptions

View from the Labs

Never mind staying safe and watching TV services from abroad, the big question is whether a VPN help you save money when buying online

Geo-located pricing makes sense where the cost of living differs radically, but a number of industries are exploiting your IP address to charge you more than you ought to be paying.

Airlines – particularly those based in the USA – are known to use your IP address's geo-location data to determine how much to charge you for a flight. If you connect to the internet from one of the wealthier parts of the USA, you could find yourself paying almost $300 more for a flight from Paris to New York than if you're connecting from France. This goes along with practices such as surge pricing (where ticket prices automatically increase if many are being bought at a given time) and other price-inflation tactics.

There's no shortage of online wisdom and folklore about how to evade this, from private browsing to clearing cookies. And you'll often see advice that you should use a VPN to locate yourself in a less wealthy country, such as Mexico or India. However, it ain't that simple.

KG Orphanides specialises in security topics and provides a regular testing service of VPNs at vpndatatracker.com
@kgorphanides

Take the example of buying an airline ticket from US carrier United Airlines, a process I recently went through. I found that simply using a VPN to ensure that I wasn't seen as being in the US, but instead in the EU, produced a significantly better price. Could it be that the EU's robust consumer protections help to dissuade American companies from trying this trick in Europe?

There are also areas where you could technically use a VPN to try to get an discount, but you definitely shouldn't. First and foremost among these is avoiding VAT. In the first place, it's illegal to dodge VAT, and most online stores will use your submitted address data to calculate VAT (even if they started out by using your geo-located IP address to create an initial estimate).

"You'll often see advice that you should use a VPN to locate yourself in a less wealthy country. However, it ain't that simple"

Something else to avoid is region-shifting on video games stores such as Steam and GOG. Regional price differences on online games stores are no longer as pronounced as they once were, but more importantly game keys are frequently region-locked. Thus, just because you can buy a game for half the price if you appear to be in Ukraine or Brazil, it won't necessarily correctly redeem to – or even be purchasable by – an account registered in the UK.

ABOVE It's much cheaper to buy the same airline ticket from some countries than others

These are just two examples. The real takeaway is that, yes, VPNs can save you money if used wisely – and legally – against those using deceptive price tactics. But user beware, as they might also cost you money in the form of unusable products.

Streaming video comparison

Provider	BBC iPlayer UK	Netflix USA	Amazon Prime Video USA	Notes
Avast SecureLine VPN	No	Yes	No	
CyberGhost	Yes	No	Yes	Streaming-specific endpoints per country and service
ExpressVPN	Yes	Yes	Yes	Netflix works on Edge but not Firefox
Mullvad	No	Yes	Yes	
NordVPN	Yes	Yes	Yes	
Norton VPN	No	Yes	Yes	
Private Internet Access	Yes	Yes	Yes	Streaming-specific endpoints per country
Proton VPN Plus	Yes	Yes	Yes	BBC iPlayer and Prime Video took multiple attempts
Surfshark	Yes	Yes	Yes	Netflix worked on third endpoint
TunnelBear	No	Yes	Yes	
VyprVPN	Yes	Yes	Yes	
Windscribe	Yes	Yes	Yes	

The Network
Practical buying and strategic advice for IT managers and decision makers

Buyer's guide

Professional desktop scanners 2025

If you can't go paperless office, at least go "paper-lite". Dave Mitchell reviews four desktop scanners that will ease you along the way

Small and medium businesses (SMBs) that want organised offices and tidy workspaces need to ditch their filing cabinets and move to document digitisation. Going paperless, or even just "paper-lite", is the way forward, and investing in a document scanner can reap many benefits, including reduced office space requirements, increased productivity and improved compliance with data protection rules.

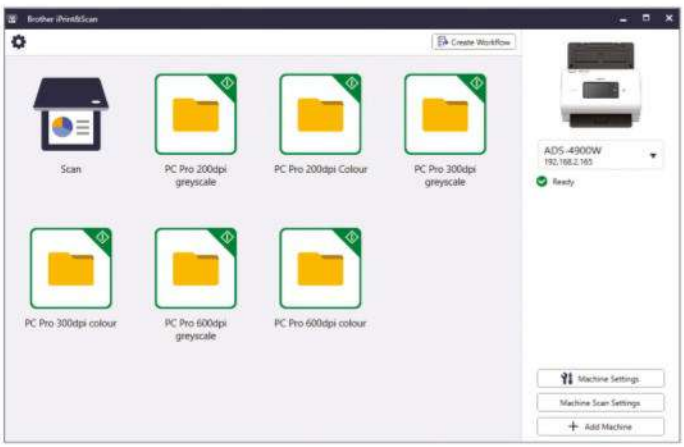
With office rental costs rising all the time, businesses can save hard cash: once paper records have been scanned, they can be sent to a secure storage facility instead of occupying large swathes of valuable office floor space. Digitisation will improve workflow efficiencies and customer experiences too, as staff won't need to waste time searching through filing cabinets looking for that crucial invoice or sales record.

Keeping paper records in an office is a big security risk since there's no easy way to protect them from unauthorised access, tampering and theft, or disasters such as fire and flooding. Digital records are much easier to protect; they can be secured with passwords and encryption and integrated into a data backup strategy.

The transformation to a digital workplace won't require a large investment either. This month, we put four business-class desktop scanners from Brother, Canon, Epson and Ricoh through their paces to help you make the right buying decision.

MFP or dedicated scanner?

Multifunction printers (MFPs) offer the convenience of print, scan and copy functions in a single device, and at competitive prices. There will be compromises, though, as most business-class MFPs have slow scan speeds plus limited paper capacities and may create a production bottleneck as users queue up to print, scan and copy from the same device.



BELOW Brother's iPrint&Scan lets you create workflows for fast one-click scans

For anything more than light duties, it's much smarter to buy a dedicated scanner. Even those in the £250–£550 price range offer fast scan speeds of 40–50 pages per minute (ppm) and large-capacity automatic documents feeders (ADFs) so they can churn through big stacks of documents without supervision.

They can handle high volumes of documents, too, with the four models in this guide offering recommended daily duty cycles ranging from 6,000 pages up to a massive 11,000 pages. Dedicated scanners offer another valuable feature you won't always find on an MFP. Double-sided, or duplex, scanning digitises both sides of a page in one pass. Without this ability, users will have to

LEFT **Canon's COT Lite Web feature provides smart driverless scanning services**

LEFT **Canon's software links document and output profiles for one-tap scans**

wait for the first side to scan, and then flip it over to scan the other side.

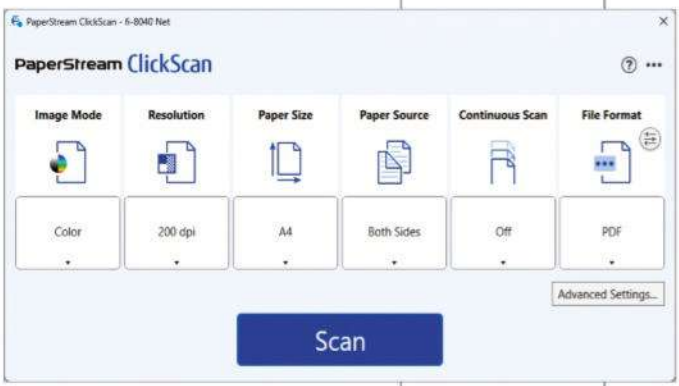
All the right connections

The cheapest desktop scanners come with a USB port for direct connection to a host PC. This is a great choice if you want to centralise all scan operations in one location, but any savings could be offset by the need to dedicate the PC to scanning and document management functions.

Wired and wireless network scanners aren't a lot more expensive and are more versatile as they don't require a host PC and can be placed in more convenient locations in the office. Access can be controlled more easily by installing the software and network drivers only on the devices you want to connect to the scanner.

You'll need a network scanner if you want your mobile workforce to get a piece of the scanning action. The best vendors offer free iOS and Android apps for that allow them to connect to the scanner, pull in scans and send them to a range of destinations.

The latest network scanners are also a lot more versatile. Remarkably, the cheapest scanner in this guide supports three operational modes, with an option to function as a completely standalone device, while another model presents a web interface that allows users to scan documents remotely without loading any drivers.



ABOVE **Ricoh's PaperStream ClickScan provides easy one-button scanning to a host PC**

Resolution conflict

All the scanners on review offer a choice of resolutions, colour or greyscale, output file formats and optical character recognition (OCR) facilities. When choosing a resolution, don't be swayed by the high numbers; in our experience, scanning at 200 dots per inch (dpi) produces perfectly readable documents. Unless you specifically require colour copies, greyscale output will also be fine.

Businesses should standardise on scan resolutions and output file formats for archiving projects to ensure consistency across their document management system. It will also save on valuable storage capacity: documents scanned at 200dpi greyscale will use a lot less space than those scanned at 300dpi colour.

"The searchable PDF format is well worth considering as it allows staff to search documents to quickly locate specific details"

For file formats, PDF is a great choice for archiving as it's widely supported and highly storage-efficient. The searchable PDF (sPDF) format will require more storage space but is well worth considering as it allows staff to search documents to quickly locate specific details such as customer names or payment details. We recommend playing with the various settings first to see which ones work best for you and then standardise it so that every employee uses the same settings.

Long distance information

The software provided with business-class scanners allows you to specify where you want scans to be sent, with typical destinations including local or networked folders and FTP servers. Ensure your users are all on the same page for destinations or else your digital documents will be impossible to locate if they're scattered across multiple systems.

The cloud is another consideration as it provides a ready-made central repository for sharing documents. Many scanner vendors offer software "connectors" that support providers such as Dropbox, OneDrive and Google Drive. Cloud-sharing providers offer secure facilities for restricting access to specific users, and you have the added bonus of off-site storage so documents can be accessed from anywhere by office staff and those working remotely.

This month we've rounded up four very affordable scanning solutions that all offer plenty of professional document management features and a choice of scan speeds. Turn the page to find out which one will conquer your paper mountain.

Brother ADS-4900W

Perfect for busy SMBs, this is a fast, versatile network scanner with a destination for every occasion

SCORE ★★★★★

PRICE £529 exc VAT from tradescanners.com

Brother's flagship desktop scanner delivers an impressive range of document digitising features at a good price. It's geared up for a heavy demand and can churn through mono and colour documents at 60ppm with a 300dpi resolution, has a generous 100-page automatic document feeder (ADF) and boasts a big daily duty cycle of 9,000 pages.

Connection options are in abundance: it offers USB-A and wired or wireless connection options, with the latter supporting 2.4GHz and 5GHz Wi-Fi 4 networks. Its large 10.9cm colour LCD touchscreen makes light work of walk-up scan operations, and menus can be easily customised to offer staff a wide range of job options.

Brother includes a good software bundle, with Windows users having the iPrint&Scan and ScanEssentials utilities, while mobile users get the Mobile Connect iOS and Android apps. You also get a firmware update tool, Tungsten Automation's PaperPort 14 SE digital file cabinet and Power PDF 3 OCR and document conversion tool.

We opted for wired network operations and downloaded Brother's general-purpose utility from its support site, entered the scanner model and watched it discover the scanner and load the Windows 11 drivers, along with the iPrint&Scan and firmware update apps. You can load the other apps from the Brother Utilities tool with the Tungsten website requiring the unique Power PDF serial number printed on the back of the scanner.

The scanner's touchscreen is easy to use and offers two basic menu pages for quick access to common tasks including direct scans to network PCs with Brother's software installed, network shares or FTP, SharePoint and email servers. You can modify these from the scanner's web interface and create new profiles that appear on the screen as quick selection shortcuts.

The touchscreen is even more flexible, allowing you to create up to 56 scan shortcuts grouped under six custom tabs. Enable the restriction management feature in the web console and shortcut access can be controlled by requiring a username and PIN.

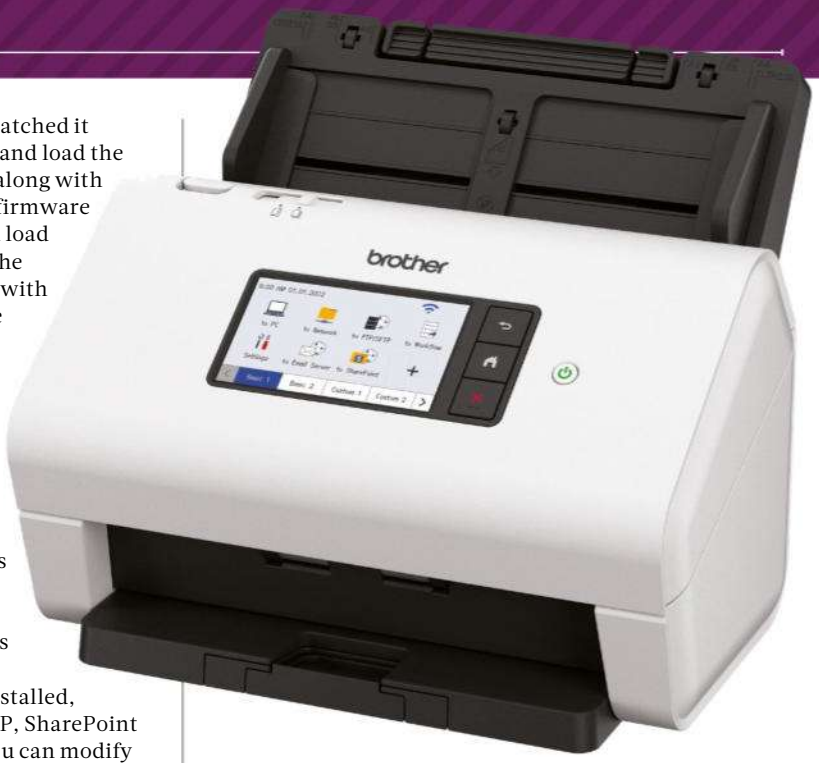
Scan-to-cloud services are outstanding. The ADS-4900W can send documents directly to Dropbox, Google Drive, OneDrive, OneNote, Evernote and Box accounts. They're simple to set up from Brother's Web Connect portal: we registered our Dropbox account, entered the unique 11-digit code on the touchscreen and PIN-protected local access.

The iPrint&Scan app streamlines desktop scanning with one-touch workflows that define local, cloud, email or other applications as destinations. Add settings such as a resolution and sPDF output and they can be registered with the scanner so they appear in its touchscreen workflow menu listed under the host's name for easy selection.

This app is the preferred choice if you also have networked Brother printers but if not, there's the dedicated ScanEssentials app which provides the same quick scan features. Brother also includes its free BRAdmin 4 SNMP software which remotely monitors all your networked scanners and printers.

Tests showed the ADS-4900W was faster than the quoted speeds, with duplex greyscale and colour scans of 50 bank statements delivering 66ppm at 200dpi and 300dpi resolutions. Moving to 600dpi saw speeds drop to 17ppm, but this won't be needed for document archiving as 200dpi produces good-quality, accurate sPDFs, with the software's OCR capabilities correctly converting every word on our statements down to small 6pt fonts.

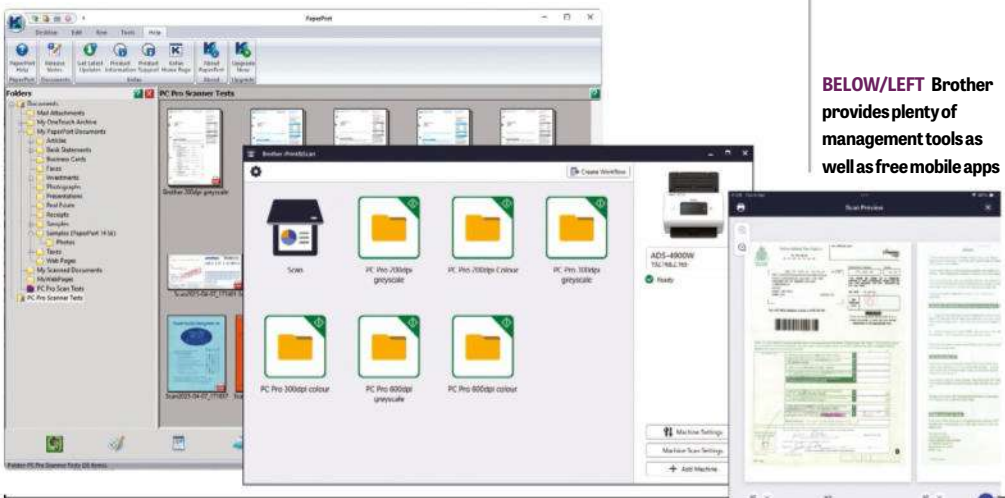
As a general-purpose networked office scanner, the ADS-4900W is hard to beat as it offers an incredible range of features at a competitive price. Scan speeds are good, output quality is excellent and Brother's top-notch software bundle and apps deliver a wealth of scanning options.



ABOVE The 10.9cm colour touchscreen walk-up scans simple

PC PRO A-LIST

"As a general-purpose scanner, the ADS-4900W is hard to beat as it offers an incredible range of features at a competitive price"



BELOW/LEFT Brother provides plenty of management tools as well as free mobile apps

SPECIFICATIONS

600dpi A4 colour scanner • 60ppm at 300dpi colour/mono • simplex/duplex • 100-page ADF • 10.9cm colour touchscreen • USB-A 3.2 Gen 1 • USB-A 2 host • 10/100 Ethernet • Wi-Fi 4 (802.11n) • 9,000 pages per day • external PSU • Brother ScanEssentials and iPrint&Scan, Tungsten Paperport 14.5 SE and Power PDF 3 software • 300 x 247 x 236mm (WDH, closed) • 3.4kg • 1yr RTB warranty

Canon imageFormula DR-S350NW

An affordable scanner with good speeds and output quality plus a smart driverless scanning feature

SCORE ★★★★☆

PRICE £433 exc VAT
from printerland.co.uk

The imageFormula DR-S350NW networked desktop scanner has a neat trick up its sleeve: you don't need to install anything to use it. Just point a browser at its IP address and you're presented with its smart CaptureOnTouch (COT) Lite web interface, which offers a range of quick scan options.

Clicking on the COT icon on its homepage presents a menu for selecting colour or greyscale, page size, resolution up to 300dpi, simplex or duplex scans, double feed detection and a passport mode. Moving to the Output page, you select PDF, JPEG or TIFF file formats, enable OCR with a choice of ten languages and hit the Scan button.

It's very easy to use, and we had no problems with Edge, Chrome or Firefox on our Windows 11 clients. When scans are pulled in they're sent to the Downloads folder, with multiple files automatically placed in ZIP archives.

Mobile users can select the COT Lite Web option in the scanner's touchscreen and point their camera at the QR code. We used an iPad and, after scanning the code, it loaded Safari with the COT Lite web interface ready to use.

Businesses that don't want these features available to all can lock them down from the browser interface using its password-protected admin settings. You can control user access with a PIN, enforce restrictions on a range of functions and save jobs to the scanner's touchscreen, which sends them as emails or to predefined network shares and FTP servers.

For traditional scan services, Canon provides Windows and macOS drivers along with its CaptureOnTouch 5 Pro scan workflow software. Installation is handled smoothly by a single downloadable utility, which loaded the Windows 11 drivers, CaptureOnTouch and a driver settings tool.

CaptureOnTouch streamlines scan operations with document profiles. These gather together settings for colour or mono scans plus a resolution, tools for blank page skipping or image rotation and batch separation controls using page counts, blank pages, barcodes, patch codes and zonal OCR.

Output profiles offer eight file formats with optional OCR, and the install routine loads plugs-ins for saving scans to local or network folders, user-defined apps, printers, FTP or SharePoint servers, and local Dropbox, OneDrive and Google Drive sync folders for cloud uploads. You can create shortcuts in the right-hand pane that link selected document and output profiles for swift one-tap scans and they can be assigned to any of 100 job numbers that appear in the scanner's display panel for easy walk-up scan operations: just choose a PC from the main menu and all assigned shortcuts are displayed for quick selection.

ABOVE You can start using the DR-S350NW without installing any software

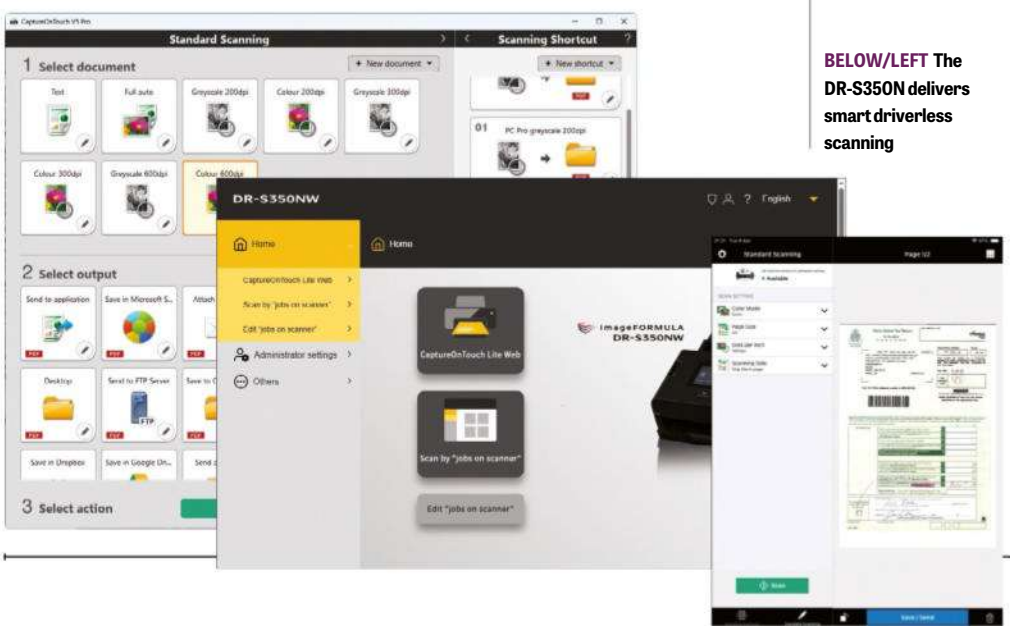
The DR-S350NW offers the same 50ppm scan speed, 60-page ADF capacity and 9,000 page daily duty cycle as the cheaper DR-S250N but you get additional support for Wi-Fi 5 connections and a more user-friendly 4.3in colour touchscreen.

Performance is good, with a 50-page bundle of bank statements scanned at 54.5ppm at 200dpi in greyscale and colour, while 300dpi returned 54.5ppm and 45.5ppm. Moving up to 600dpi mustered 21ppm for greyscale scans, while colour dropped speeds to a pedestrian 11.4ppm.

"Performance is good, with a 50-page bundle of bank statements scanned at 54.5ppm at 200dpi in greyscale and colour"

For document archiving, we found 200dpi is perfectly adequate, with sPDFs showing correctly converted fonts down to 6pt. One feature that will appeal to small offices is that this is one of the quietest scanners we've tested.

Canon's imageFormula DR-S350N is a versatile office desktop scanner at an appealing price. The COT Lite Web feature delivers smart driverless scanning, performance and output quality are good, and CaptureOnTouch offers an impressive range of scan management features.



BELOW/LEFT The DR-S350N delivers smart driverless scanning

SPECIFICATIONS

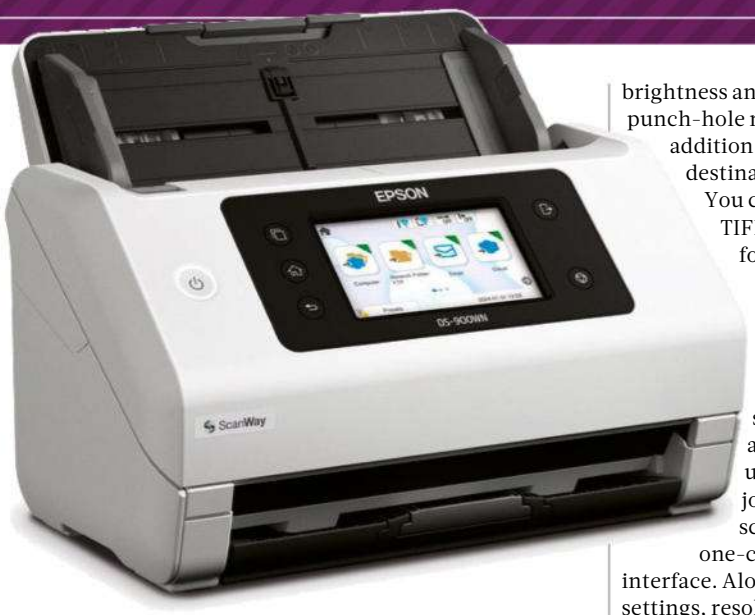
600dpi A4 colour scanner • 50ppm at 200dpi mono/colour • simplex/duplex • 60-page ADF • 4.3in colour touchscreen • USB-A 3.2 Gen 1 • gigabit Ethernet • Wi-Fi 5 • 9,000 pages per day • external PSU • Canon CaptureOnTouch V5 Pro and Driver Setting software • 291 x 267 x 242mm (WDH, closed) • 3.4kg • 1yr standard hardware warranty

Epson WorkForce DS-900WN

It's pricey, but this EdgeLink-enabled desktop scanner is incredibly fast and delivers good-quality scans

SCORE ★★★★☆

PRICE £1,135 exc VAT
from ballicom.co.uk



Businesses with a need for speed will love Epson's WorkForce DS-900WN as this desktop scanner claims top speeds of 70ppm. It can do this for greyscale and colour scans at 300dpi, while the 11,000-page daily duty cycle and 100-page automatic document feeder are geared up for a high demand.

The price is steep but the DS-900WN offers a lot for your money. As one of Epson's ScanWay models, it can function as a standalone network device for walk-up scanning, and membership of the EdgeLink club brings in support for Epson's Open Platform.

This allows third-party independent software vendors to embed their document and data management software in the scanner's web GUI and customise the icons on its large 10.9cm colour touchscreen. A good example is DocuSoft, which can enforce user authentication at the scanner and automatically catalogue, index and place scans in predefined storage repositories.

The scanner can also be integrated into Epson's scanner management tools. These include Epson's Device Admin for centralised fleet management, along with its Print Admin (EPA) and EPA Serverless for user authentication and secure scanning services.

Installation on our Windows 11 PCs was a breeze. We downloaded the utility from Epson's support site, which handled all driver and software deployment. We opted for a gigabit wired network connection (Wi-Fi 5 is also supported) and the utility discovered the scanner, ran an instant firmware update and loaded Epson's Scan 2 and Document Capture Pro tools.

Epson's Scan 2 utility can be used for quick scans to local or network destinations and comes into play when you acquire scans from other apps using the TWAIN driver. It offers plenty of scan controls to select a resolution, colour, greyscale or mono scans, document and contents skew correction, simplex or duplex operations and blank page skipping.

From the advanced settings tab, you can apply text enhancements, brightness and contrast controls, punch-hole removal and watermark addition, and send the scan to two destinations simultaneously. You can pick from BMP, JPEG, TIFF, PDF and sPDF output formats, and when you've finalised your choices you can save them as quick access profiles.

ABOVE **Epson's DS-900WN is a fine choice if you want super-fast scan speeds**

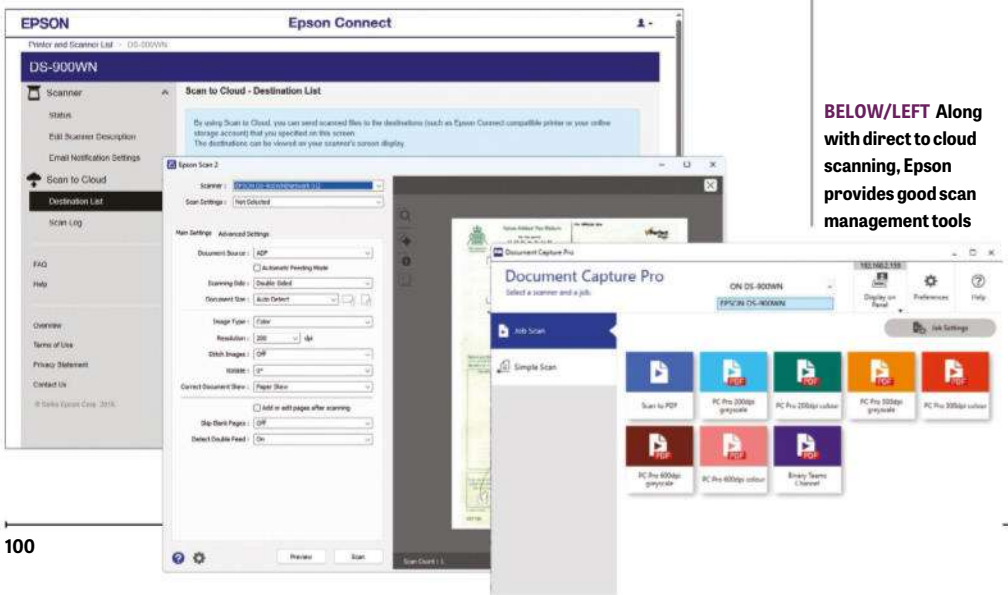
Document Capture Pro provides sophisticated scan automation services; we used it to create multiple jobs for different types of scans and save them for one-click access from its main interface. Along with defining scan settings, resolutions, output formats and destinations, you can apply job separation indexes using features such as patch codes, barcodes, forms and OCR detection areas.

Scan destinations are abundant, with support including email to an SMTP server, FTP and SharePoint servers plus direct saving to Dropbox, Evernote, OneNote, Google Drive, OneDrive and SugarSync. You can also assign button numbers to each job and make them available in the scanner's control panel. Epson even includes a Microsoft Teams connector and logging it into our MS 365 account allowed us to send scans directly to selected channels and document libraries.

"You pay a premium for EdgeLink support, but this makes the DS-900WN very versatile as it can be easily integrated with document management processes"

The DS-900WN easily achieved its claimed speeds, with a stack of 50 bank statements scanned at 71.4ppm for greyscale and colour at both 200dpi and 300dpi resolutions. Greyscale and colour scans at 600dpi dropped speeds to 22ppm and 19.4ppm respectively, but you won't need this for document archiving as we found 200dpi was acceptable, with Epson's OCR plug-in correctly converting small 6pt fonts.

You pay a premium for EdgeLink support, but this makes the DS-900WN very versatile as it can be easily integrated with business document management processes. It offers lots of connection choices, Epson's software provides great scan management features, and it delivers a high scan speed.



BELOW/LEFT **Along with direct to cloud scanning, Epson provides good scan management tools**

SPECIFICATIONS

600dpi A4 colour scanner • 70ppm @ 300dpi colour/mono • simplex/duplex • 100-page ADF • 10.9cm colour touchscreen • USB 3 • gigabit Ethernet • Wi-Fi 5 • 11,000 pages per day • external PSU • Epson Scan 2, Document Capture Pro software • 296 x 212 x 217mm (WDH – closed) • 3.7kg • 1yr on-site service warranty

Ricoh fi-8040

An affordable scanner with a nippy turn of speed, top output quality and a big choice of operational modes

SCORE ★★★★★

PRICE £249 exc VAT
from thescannershop.com

ABOVE **Ricoh's fi-8040 is a highly affordable, versatile scanner**

Ricoh offers an impressive range of desktop scanners, and the affordable fi-8040 on review is one of its most versatile. Using Ricoh's embedded DirectScan feature, it can function as a completely standalone network scanner, it supports host-based operations using its USB or gigabit port, and it can be remotely managed and configured with the PaperStream NX Manager app.

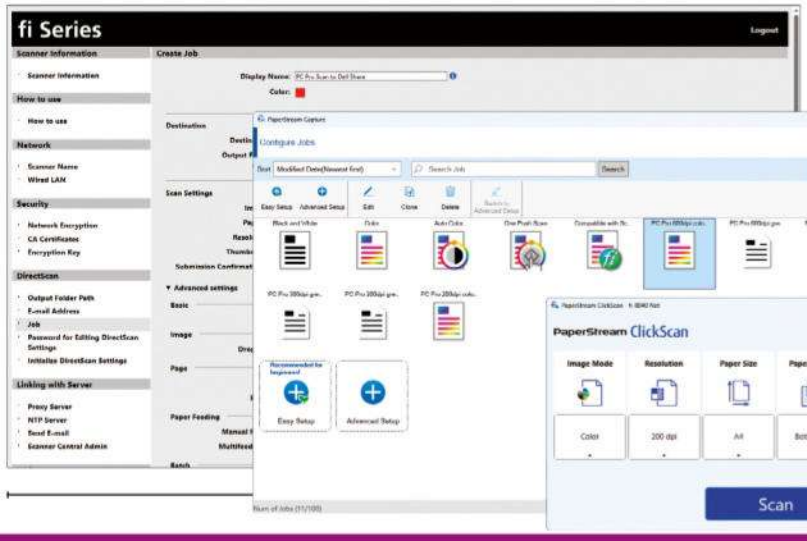
Installation is old-school as your host PC will need an optical drive. Fortunately, after loading the DVD in our Windows 11 test client, it offered the opportunity to skip the local files and download all the latest versions.

For host-based scanning you have two choices, with Ricoh's PaperStream ClickScan for Windows providing simplified one-touch scanning services. We loaded it on a Windows 11 PC and used a network connection to access the scanner and set functions such as greyscale or colour, a resolution, paper size and an output format.

The app is loaded from the system tray and you can set destinations for local folders, email attachments, direct printing or third-party apps. On first contact, make sure you check out the upper right-hand menu as it offers downloads for SharePoint, Dropbox, Google Drive and OneDrive connectors plus a plug-in for creating searchable PDFs.

In ClickScan mode, the fi-8040 presents a big soft button on its generous 4.3in colour touchscreen. With one finger tap, it will scan the documents loaded in its 50-page automatic document feeder using all the settings you defined on the host PC. You can also initiate scans from the software.

For scan speed, Ricoh claims 40ppm, and that's what you'll get. In fact, during our ClickScan tests the fi-8040 was slightly faster as it delivered a tidy 43.5ppm for greyscale and colour scans at 200dpi and 300dpi. Move up to 600dpi and it will slow down to only 11ppm, but unless you're scanning photos, you'll only need a 200dpi setting for archiving as this delivers excellent results, with Ricoh's OCR component cleanly converting small 6pt fonts.



BELOW/LEFT **The fi-8040 supports a choice of integrations**

For those that want even more scan controls, there's Ricoh's PaperStream Capture. As with ClickScan, it can access the scanner over the network using the PaperStream IP TWAIN driver and provides sophisticated scan workflow management and batch processing.

Its customisable profiles combine scan settings, destinations, page indexing and automatic page separation using indicators such as barcodes. During profile creation, you choose the settings configured in the network driver, or you can override them, select output scan settings including OCR and define destinations from the same list as available with ClickScan.

Document separation can be implemented using blank pages, page counts, predefined OCR zones or barcodes, and you can assign profiles to the scanner's screen menu using the Capture administrator tool. Add the paid-for Capture Pro upgrade and you can extract data from documents as they're being scanned with a profile's Meta Data option.

DirectScan mode can be enabled in the scanner's screen menu or from its web interface, which provides easy access to all settings for defining network shares and FTP servers, as well as SMTP mail servers. The scanner's screen changes to the DirectAccess menu which provides soft buttons for sending scans to predefined storage locations and email addresses.

PC PRO RECOMMENDED

"Ricoh's fi-8040 offers SMBs a remarkable range of scan features for a very good price. Output quality is beyond reproach"

After choosing the destination, you can select from a range of options and, on scan completion, the screen shows thumbnails of all pages and a button to send the document. To simplify scans even further, you can create jobs that combine destinations and all desired scan settings.

Ricoh's fi-8040 offers SMBs a remarkable range of scan features for a very good price. Output quality is beyond reproach, it delivers on its performance promises and the multiple operational modes makes it highly flexible.

SPECIFICATIONS

600dpi A4 colour scanner • 40ppm @ 300dpi colour • simplex/duplex • 50-page ADF • 4.3in colour TFT touchscreen • USB-A 3.2 Gen 2 • gigabit Ethernet • 6,000 pages per day • external PSU • PaperStream IP TWAIN/ISIS drivers • PaperStream ClickScan, Capture and NX Manager, ABBYY FineReader software • 292 x 157 x 143mm (WDH – closed) • 3.1kg • 3yr advanced exchange warranty

LincPlus LincStation N2

A smartly designed, affordable all-flash desktop NAS with plenty of storage features and good 10GbE performance

SCORE ★★★★½

PRICE Diskless, £354 exc VAT
from lincplustech.com

ABOVE **The LincStation N2 is a diminutive tour de force with a range of useful connectors**

The LincPlus LincStation N1 impressed us on many levels when we reviewed it last year (*see issue 362, p102*), although we did bemoan the fact that the undeniable performance potential of this all-flash appliance was restricted by its 2.5GbE network port. The LinkStation N2 makes our wishes come true as it sports a 10GbE port but goes a lot further with even more upgrades.

Physically the 35mm high chassis is the same, but the quad-core 2GHz Intel Celeron N5105 CPU in the N1 gets the elbow for a more modern quad-core Intel N100, which boasts a top burst frequency of 3.4GHz. Memory has also been improved: the N2 is endowed with 16GB of faster DDR5 soldered on its motherboard.

Storage potential remains the same, with two SATA SFF carriers behind the front flip-down panel and four M.2 NVMe SSD slots underneath. The N2 keeps the front-mounted USB-C 3.2 Gen 2 port, while at the rear you now have one USB-A 3.2 Gen 2 and a doubling of USB-A 2 ports, plus a 3.5mm audio-out jack and an HDMI 2 port for receiving 4K video from the CPU's integrated GPU.

The cooling design has also been updated. The chassis has a small and very quiet internal fan, while its metal base has extra slots in the centre to improve airflow. The N100 CPU has a thermal pad to help dissipate heat to a chassis-wide metal plate, the SFF carriers are aluminium, and the NVMe SSD slot covers are ribbed metal heatsinks with thermal pads already fitted.

The appliance is ready for action, with Lime Technology's Unraid software pre-installed. A scratch card in the box has a licence key for the Starter version, which supports up to six storage devices and includes one year of software updates, with yearly extensions costing around £27.

One component that's gone walkabout from the N1 is the internal Intel AX201 Wi-Fi 6 adapter. This is a shame as Lime Technology recently released a public beta of Unraid 7.1, which features native Wi-Fi support.

Initial installation is simple enough, as you point a browser at the appliance and set a new admin password. From here on in, however, it gets tougher; we recommend taking time out to understand Unraid as it can present new users with a steep learning curve.

Unraid aggregates storage devices and protects them with a parity drive. This should have the largest capacity of all installed devices and, for testing, we fitted two 1TB Western Digital SATA SSDs, nominated one as a parity drive and assigned the second to the array for storage. You can add NVMe SSDs to the array or assign them to a pool and use them as cache drives to improve performance.

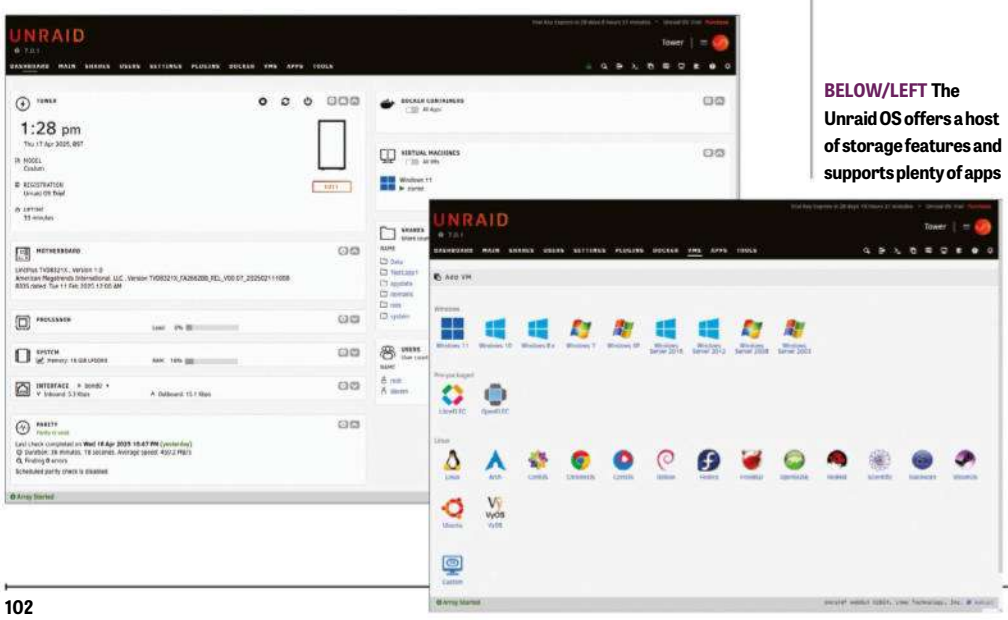
Network shares are simple to create, and Unraid provides plenty of access security. You can set them for public access, make them secure so only authorised users can write to them or make them private for more granular user controls.

Unraid does a lot more than file sharing; it offers plenty of apps including backup, media servers, network services and home automation. Virtualisation support is pre-installed and it can host Docker containers along with Windows or Linux OSes.

"This innovative and eminently portable 6-bay all-flash desktop NAS is a good choice for small businesses and is great value"

The 10GbE port has a huge impact on performance, as the N2 is a lot faster than the N1. With a share mapped over 10GbE to a Windows Server 2022 host, we recorded sequential Iometer read and write speeds of 8.7Gbits/sec and 7.7Gbits/sec with random operations returning 8.1Gbits/sec and 5.9Gbits/sec. The N1 and its 2.5GbE port only managed 2.2Gbits/sec across the board.

The LincStation N2 builds on the successes of the N1: along with a faster CPU and memory, it delivers the 10GbE network port the N1 was crying out for. This innovative and eminently portable 6-bay all-flash desktop NAS is a good choice for small businesses and is great value, costing around the same as the first-generation N1. **DAVE MITCHELL**



BELOW/LEFT **The Unraid OS offers a host of storage features and supports plenty of apps**

SPECIFICATIONS

Desktop chassis • quad-core Intel N100 CPU • 16GB LPDDR5 RAM • 128GB eMMC storage • 2 x SATA SFF bays • 4 x PCIe Gen 3 M.2 2280 NVMe SSD slots • 10GbE • USB-C 3.2 Gen 2 • USB-A 3.2 Gen 2 • 2 x USB-A 2 • HDMI 2 • 3.5mm audio • 60W external PSU • Unraid Starter OS pre-installed with 1yr support • 210 x 150 x 35mm (WDH) • 1.8 kg • 1yr hardware warranty

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3 for free

Warranty extended to **3 years** on selected RICOH fi Series scanners*

From now until 30th June 2025, when you buy a **RICOH fi-8040, fi-8150, fi-8170, fi-7460** or **fi-7480** business scanner from our RICOH fi Series range, we're offering a free 3 Year Warranty* upon registration.

fi-8040
Enables PC-less scanning

fi-8150
Flexible capture, A4 50ppm

fi-8170
70ppm, 10,000 daily throughput

fi-7460
A3 capable, compact, 60ppm

fi-7480
80ppm, 100 sheet ADF

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SCAN S
01204-474747 | scan.co.uk

*Offer ends 30/06/25. Terms & conditions apply.

Ubiquiti UniFi UNAS Pro

Modest performance and features, but the UNAS Pro offers a high storage capacity at an incredibly low price

SCORE ★★★★☆

PRICE Diskless, £395 exc VAT from broadbandbuyer.com

Ubiquiti's UniFi family has a well-deserved reputation for delivering classy managed wireless network solutions, and the company is now making a play for the business network-attached storage (NAS) space. It aims to make a big splash as its low price makes the UNAS Pro one of the most affordable appliances on the market.

Aimed at large-scale file storage and sharing, this 2U rack-mounter sports seven LFF/SFF drive bays. This is an odd number for a NAS appliance, but Ubiquiti has forsaken an eighth bay so it can fit its trademark LCD touchscreen operator panel on the left, along with copper gigabit and 10GbE SFP+ fibre ports on the right.

It's powered by the same 1.7GHz quad-core Arm Cortex A57 CPU as found in many of Ubiquiti's Dream Machine gateway appliances, and this is teamed up with 8GB of non-upgradable DDR4 memory. No PCIe expansion slots or USB ports are provided but a rear connector supports Ubiquiti's optional Power Backup appliance.

The UNAS Pro can be deployed in standalone mode, but if you go down this route you won't have access to remote management, multi-factor authentication (MFA), notifications or cloud backup services. It makes far more sense to cloud-manage the appliance using Ubiquiti's free portal, which brings every feature into play.

Think carefully about the storage devices, too, as only a single pool is supported. You can expand the pool by adding more drives later on, but they must be the same size and type as the existing drives or larger.

For testing, we fitted four 22TB Western Digital Red Pro NAS hard disks in the metal carriers, powered the appliance up, loaded the UniFi app on an Apple iPad and logged it into our UniFi account. The app discovered the appliance, listed the four drives and asked us to select a protection policy.

We chose the basic policy, which created a RAID5 array using all four drives. For two drives, it will create a RAID1 mirror, and with four or six drives you can choose the performance policy which creates a RAID10 mirrored stripe.

During this phase, the UniFi Drive app was automatically installed on the appliance and, once adopted, it popped up in our account's top-level Site Manager portal. We have a live UniFi Dream Machine Pro (UDM Pro) appliance in the lab, and the portal offered to merge the UNAS Pro with it for single-site management.

The portal's dashboard provides a detailed status view of all things storage-related as well as easy access for setting up file shares. These are created from the "All Files" page, where you can enforce a storage limit, decide which users have access and apply encryption if required.

ABOVE Ubiquiti's UNAS Pro unusually comes with seven bays

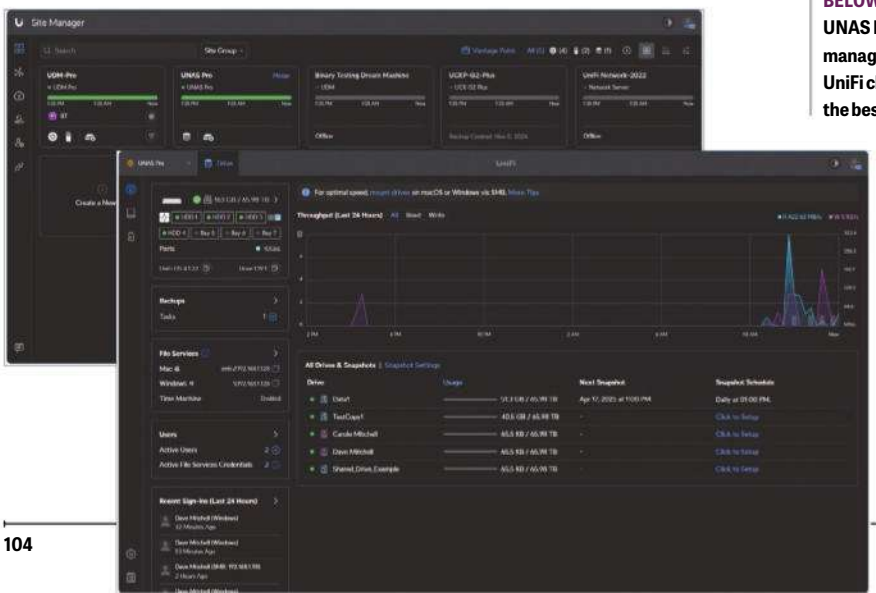
Performance over 10GbE was a mixed bag, with a share mapped to Window Server 2022 host returning respectable raw sequential Iometer read rates of 8.1Gbits/sec but a lower 5.1Gbits/sec for writes. Real-world test results were significantly slower, with copies of a 25GB file between the NAS and server delivering average read and write speeds of 2.4Gbits/sec and 2.1Gbits/sec.

"The UNAS Pro is aimed at businesses that want pure and simple NAS services and is a natural choice for those already invested in Ubiquiti's hardware"

Apps are in short supply, with services such as iSCSI not available, although all the basics are covered. Accessed from the Settings page, scheduled backup jobs secure local data to a remote UNAS Pro appliance, a CIFS/SMB share on another host or to a Google Drive account.

Snapshots can be run manually on selected shares or scheduled for regular intervals, with the appliance supporting 256 per share and a total of 4,096 for the system. To recover snapshot data, you choose a shared drive, double-tap the snapshot icon, pick a version and restore it completely or browse its contents for specific files.

The UNAS Pro is aimed at businesses that want pure and simple NAS services and is a natural choice for those already invested in Ubiquiti's cloud-managed hardware. It can't match the likes of Qnap and Synology for features and apps, but its sub-£400 price tag beats them soundly for value. **DAVE MITCHELL**



BELOW/LEFT The UNAS Pro should be managed from the UniFi cloud portal for the best experience

SPECIFICATIONS

2U rack chassis • quad-core 1.7GHz Arm Cortex A57 processor • 8GB DDR4 RAM • 7 x LFF/SFF hot-swap SATA drive bays • 1GbE • 10GbE SFP+ • 200W internal PSU • 2yr hardware warranty

HOW SCANNING IS GIVING BUSINESSES A SECURITY AND EFFICIENCY EDGE IN 2025

Greig Millar, chief revenue officer at Brother UK, explains how scanning and cloud solutions are transforming efficiency and security in the evolving hybrid workplace

Businesses today are navigating a workplace landscape that has evolved significantly in just a few years. The hybrid working model, which initially emerged as a necessity, has now become an integral part of workforce strategies. Some businesses are downsizing office spaces, investing in flexible work hubs, and prioritising cloud-based infrastructure to support employees wherever they choose to work.

Others major employers – including JPMorgan Chase, Boots and Amazon – are encouraging employees back into the office, recognising the value of in-person collaboration. Regardless of the approach, IT decision-makers face the same key challenges: optimising productivity, ensuring document security and managing costs.

With increasing compliance regulations and a growing need for businesses to digitise their workflows, document management solutions have never been more critical.

Closing security vulnerabilities

Security remains a top concern for IT leaders managing a distributed workforce, and ensuring the safe handling of documents – both digital and physical – is a major priority for businesses operating across multiple locations.

Document security vulnerabilities can sometimes be underestimated. Manual scanning processes can create unnecessary risks, from misplaced files to unauthorised access, and lead to human error. Robust document management and cloud-enabled print solutions play a crucial role in mitigating these risks by integrating advanced security features into everyday workflows.

We've partnered with Tungsten Automation, a leading software developer known for its expertise in document automation and security, to create Brother Cloud Solutions (BCS): an example of a service making security and document management simpler.

BCS provides secure, scalable and cost-effective ways for businesses to manage print and document workflows, and has allowed us to integrate advanced security, authentication and workflow automation features into everyday business operations.

For businesses with multiple locations or remote employees, cloud-based printing ensures seamless connectivity. Through BCS integration with Tungsten Automation's AutoStore and Printix, employees can access and edit scanned PDFs securely from any device using tools such as PowerPDF and SignDoc, which offer search and redact features, ensuring that only the necessary information is visible to those with authorised access to cloud-stored documents.

Meanwhile, with solutions like ControlSuite, businesses can enforce user authentication, document encryption and detailed access logs, reducing the likelihood of human error and potential security breaches. This capability is particularly valuable for businesses handling sensitive records, such as law firms managing court bundles or healthcare organisations processing patient documents. With ControlSuite, businesses benefit from advanced authentication and tracking, ensuring that documents are only accessed by authorised users.

Tools like these are why cloud technology has become a fundamental part of modern IT infrastructure, optimising document management and minimising the chances of scanning being the weak link in the chain that would-be data thieves look to exploit.

Award-winning innovation

Quality hardware is just as essential as quality software. Our ADS scanner range, combined with Brother ScanEssentials software, enables businesses to create seamless digital workflows. The ADS series delivers high-speed scanning at up to 60 pages per minute with a 100-sheet capacity, making it one of the fastest and most reliable solutions for high-volume document processing.

By streamlining the workflow, automated document handling is essential for reducing manual administrative work, improving productivity and saving time. Also, Brother's scanning solutions allow businesses to automatically name, store and route documents to the correct location, eliminating inefficiencies caused by misplaced files.

Ultimately, automating these processes frees up employees' time, enabling them to focus on other tasks and explore new opportunities for growth.

Enabling secure and cost-effective hybrid working

Robust document management technology that's proven to narrow security gaps will be crucial as IT decision-makers continue to mould their IT infrastructure around their employers' changing footprint and practices.

A recent poll of 79,000 firms by Peninsula Group found that the number of SMEs offering flexible working as standard nearly doubled to 28% in 2024. This highlights how hybrid working has continued to evolve. However, uncertainty remains as the UK government consults on legislative changes that could make remote working the default option. Its success, however, depends on having the right technology infrastructure in place.

This will go to show how cloud-enabled document management solutions can make hybrid working easier by ensuring employees can scan, access and edit documents securely, from any location. Whether they are working from home, in a shared workspace or in the office, employees have the same level of access and functionality.

Hybrid workforces also require increased collaboration between remote and in-office employees. Using cloud print solutions, integrated with Printix, supports real-time document sharing and secure cloud printing, ensuring that employees can print and share files as easily as they would in a traditional office setup.

Future-proofing document management

Innovation in document management solutions is essential in helping businesses adapt to new ways of working. Investing in cloud-enabled document workflows, secure print solutions and high-performance scanning technology will be essential for maintaining efficiency, security and compliance.

The demand for automation and AI-driven document processing is expected to grow, and there remains a strong commitment to innovation in these areas. This will enable businesses to streamline administrative tasks, reduce security risks and create more efficient workflows.

Security and compliance requirements will also continue to evolve, making it essential for businesses to stay ahead of regulatory changes. Brother's cloud-integrated security features provide IT teams with the tools they need to protect sensitive information, whether in the office or across a distributed workforce.

Our continued investment in cloud-enabled document solutions and automation ensures businesses have the tools they need to navigate an increasingly digital world, and to achieve greater resilience while reducing operational costs.

To find out more about the ADS4 range, visit www.brother.co.uk/desktop-scanners

Software licence MANAGEMENT

In an age of remote working and hosted services, it's more important than ever to keep track of your licences. Nik Rawlinson looks at the challenges – and offers some practical advice to help you avoid accidental non-compliance

Keeping track of what software you're using – and what software you're entitled to use – might not sound like rocket science. But when NASA audited its own usage in 2023, it made some sobering discoveries. In the absence of a centralised licence-management process for software, the audit report estimated that the agency had wasted around $15 million over the previous five years on unused licenses.

And if that sounds expensive, there was worse to come. Auditors also found that the organisation had "historically experienced a large influx of software into its network environment that is not sufficiently tracked for licence compliance, resulting in more than $20 million unnecessarily spent on software fines and penalties over the last five years."

If such a high-tech, risk-averse organisation as NASA can make such mistakes, what's going on in your business?

Licensing complexity

While few businesses are as big as NASA, the licensing challenges it faces are shared by every organisation. For one, licensing is typically managed centrally, by an IT or systems team – but expecting a single department to understand the needs of all stakeholders is a big ask. This is particularly true as BYOD and hybrid working models become more and more common.

An alternative option is to delegate procurement or licence management to department heads. But while this might give you a better, closer view of what software your business is actually using, it requires those department heads to understand legal and technical specifics, such as the difference between perpetual, subscription, open-source, by-network, public, permissive, database, site and other licence models. Realistically, their expertise is more likely to lie elsewhere.

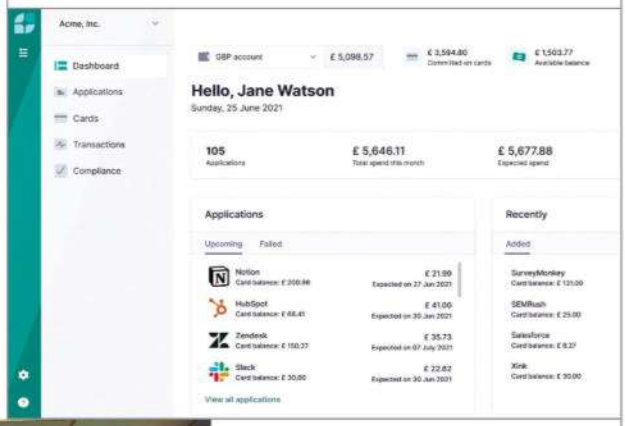
And regardless of what processes you have in place, empowered workers will very often come up with their own workflows, either ignoring software that's been provided for them or using unofficial tools that they've selected and installed themselves – so-called "shadow IT". Without careful administration – often with help from a dedicated software licensing management platform – you could be not only wasting money on unneeded licences, but exposing the organisation to penalties for licensing violations.

"Even in the most sophisticated businesses, with the most developed IT functions and control infrastructure, a very large percentage

of their software purchasing is either completely shadow IT or very decentralised and not well managed," Brad van Leeuwen told *PC Pro*. He's COO and co-founder of Cledara, which claims to be the world's leading software-management platform for finance teams, with a particular focus on SaaS and cloud subscriptions.

It's a product that grew out of van Leeuwen's personal experience. Prior to starting Cledara, van Leeuwen had been responsible for building up a fast-growing business: "When we started, I just put my credit card on the table and told the team that we were going to build our product and sell it. We weren't going to focus on having a lot of operational processes that we didn't need."

Fast forward a couple of years, and things had got complicated. "The business grew super-fast," van Leeuwen recalled, "and what had happened was a lot of people had come along, grabbed my credit card, bought a piece of software that they needed with it... and after a while, our second largest expense in the business, after payroll, was SaaS and cloud. We had no idea what software we had, why we had it, if we still needed it, if it was being used, and who had access."



Realising this situation wasn't sustainable, van Leeuwen's company undertook a comprehensive audit, with a view to cleaning up and rationalising its software use. As part of that process, it pulled together a company-wide spreadsheet to document the state of play.

"And we saw a ton of problems," he said. "There was software that no-one knew about, software that was very clearly duplicated, and a lot of money being wasted as a result."

To help get a grip on the situation, he started searching for what he likens to an HR system for software – and quickly found that no such platform existed. It was at that point that he teamed up with Christina Vila, who had had a similar experience in Fintech, to establish Cledara, with a mission to give companies visibility and control over the cloud software they rely on to run their business.

The platform is designed to give a complete view of an organisation's software stack, no matter how its various components were acquired. It encompasses "software that you've procured centrally or which has been procured by the battlefield IT procurement manager – and maybe even an individual contributor buying their own software to do their job, and the software that you don't even know about... We help you understand what's being spent and how it's being used, as well as automating finance and IT type processes around that software each month, each quarter and each year."

TOP Cledara can help businesses keep track of their licences – and their actual expenditure

ABOVE A software audit at NASA revealed that it had wasted millions of dollars on licensing

Van Leeuwen claims that organisations who onboard with Cledara save at least 30% on their cloud software bill.

Licence to bill

Software licences are often lengthy documents, and complicated legal agreements can potentially leave vendors and users disagreeing as to their interpretation. One notable example is the 2016 court case between software provider SAP and drinks giant Diageo. SAP argued in London's High Court that Diageo's online ordering system was breaching the terms of its software licence by allowing its customers to place orders online via a portal that interfaced with a SAP service. Even though Diageo had paid as much as £60 million to SAP for the use of its services, the court agreed that 5,800 of Diageo's customers would also need to be individually licensed as named users, at an additional cost of more than £50 million.

Concerningly, such issues might only become apparent following a licence audit, either conducted by a vendor itself or outsourced to a third party such as Deloitte. An external audit will typically cover your entire software stack, from locally installed tools to server applications, in an effort to ensure not only that every piece of software has been paid for, but also that it is deployed in its intended manner. For example, an audit will consider not only whether an organisation employing 50 instances has paid for 50 seats, but whether it's purchased the right sort of licences to cover its actual usage.

In some ways such an audit is similar to a tax audit, and in both cases things will go a lot more smoothly if you have comprehensive documentation to support your usage. And it's important to plan ahead, because you might not get to decide when and how an audit happens: if your organisation makes use of Creative Cloud, for instance, you've already granted Adobe permission to audit your use of its products and services. Per the licence agreement, the publisher may, "no more than once every twelve months, upon at least seven days' prior notice to you, appoint our personnel or an independent third-party auditor... to inspect (including manual inspection, electronic methods or both) your records, systems and facilities to verify that your installation and use of Services or Software comply with our Terms. Additionally, you will provide us with all records and information requested by us within thirty days of our request in order for us to verify that the installation and use of any and all Services and Software is in conformity with your valid licences."

As if that weren't exacting enough, you've also agreed, in installing Creative Cloud, that if the audit reveals a "shortfall in conformity" you'll "immediately acquire any necessary licences, subscriptions and applicable back maintenance and support or other applicable action in order to remedy any such non-conformity(ies)". Whether it's Adobe or any other vendor, if an audit finds that you're been non-compliant for some time you could be suddenly landed with a hefty bill.

Choosing the right licence

Software licence management goes beyond checking that you have a valid licence for each seat. You should also track exactly how your licensed software is being used – particularly if multiple licence types were on offer at the point of procurement.

Last year, Orange found itself in the Paris High Court for failing to comply with the terms of a GNU/GPL licence when incorporating code developed by Entr'ouvert into a portal

for government services. The code that it employed – Lasso – was a single sign-on system, available under both GNU/GPL, and commercial licences. Any use of the software under terms of the GNU/GPL licence was free, but required the developer to release the resulting product under a similar licence. If this was incompatible with their intended use, they could instead purchase a commercial licence. Orange opted for the former, and was taken to court for not open-sourcing its own product.

The resulting legal process took nine years to complete, and although the initial judgment cleared Orange of copyright infringement, the company was fined more than €800,000 in 2024 – because its use of Lasso didn't fall within the terms of its contract with Entr'ouvert.

Where software is available under multiple licence models, it's important for organisations to understand the implication of each model, and to monitor their ongoing use to ensure continued compliance. As global law firm DLA Piper notes, "the majority of the award against Orange was intended to compensate Entr'ouvert for the amount Entr'ouvert... might have been paid if Orange had entered into a commercial licence to use Lasso. Users of open-source software must be aware of the potential for such additional damages resulting from their violation of open-source licences when that software is available under a commercial licence, which may be used as a basis for calculating a damages award."

Today, the use of licensed software is usually defined by standard legal agreements, but we're starting to see a few vendors rolling out "smart contracts" – software triggers that detect when you do something that requires a particular licence, such as accessing an API or logging in to an SaaS account. This lets the vendor verify compliance in real-time, and either allow the action or alert the user that a licence upgrade is needed – perhaps offering the option of an immediate upgrade, or a payment for one-off access.

Smart contracts can benefit both the vendor and licence holder: customers can more easily manage their ongoing costs, as they pay for actual usage rather than having to estimate how many licences they may require. Vendors, meanwhile, can be sure only authorised users with a valid licence are able to access their service.

Both sides can also enjoy a faster, more responsive system. Microsoft's old Xbox royalties platform took 45 days to calculate what was owed to developers, but once it partnered with EY to implement a smart contract system that time was cut that to just four minutes, allowing developers to check earnings on a near real-time basis. Applying similar technology to software licensing would likewise allow for immediate verification.

Another move is towards using a blockchain to track licence usage, rather than static documents. Professional services company Accenture completed its first transactions using distributed ledger technology (upon which blockchains are based) in 2018 to enforce software licence events throughout their life cycle, from origination to purchase.

This approach would probably require a big adaptation for most organisations, but it's a sign of the evolution under way in software asset-tracking and management tools. Accenture Operations blockchain lead senior principal Melanie Cutlan explained that the use of distributed ledger technology can "simplify the traceability of licences and, therefore, the auditing function, so all can see where each licence is assigned... [which] has the potential to save organisations millions of dollars per year in the management of their software licence portfolios."

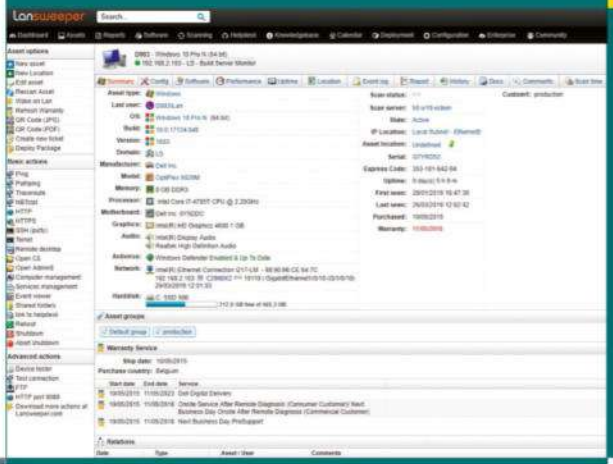
BELOW Understanding the terms of the licence agreement is absolutely vital

How to prepare for a software licence audit

1 Make sure you understand the scope of the audit and what you agreed to as part of the EULA. Re-read the licence agreement for each product to get a clear idea of what the auditor is likely to require. Do the terms permit hands-on access to your systems, for example? If so, consider any relevant security and privacy implications. Appoint someone in-house to lead the necessary preparations and to liaise with the auditor, who may be a third party appointed by the vendor in question. If you have a legal department, ensure they're aware of the audit before it takes place, and keep them updated as it progresses.

2 Assemble all relevant supporting documentation, such as invoices, purchase orders, contracts and correspondence. Work towards compiling a "single source of truth" for your software, digital assets, API usage and so on.

BELOW Lansweeper scans your network to discover all installed software – both licensed and otherwise



3 Check what software you're actually running. Tools such as Lansweeper (**www.lansweeper.com**) can help you to compile a list of software assets by scanning connected hardware over the network and listing both the hardware itself and the apps deployed to it. Keep a special eye out for software installed without authorisation by end users – if it's being used in a business context or running on a machine owned by the business, it may fall within the purview of the audit. Bear in mind too that some assets may be hosted on cloud instances, so check that users aren't sharing logins if each one needs an individual named account. Similarly, be mindful of the difference between user limits and device limits; some software, for example, can be set up on multiple devices so long as they are not used simultaneously.

4 Ensure you're using not only the right software, but the specific version covered by your licences. If you identify any overuse, unlicensed use or use beyond specified limits, remedy this in advance of the audit if possible. While this won't necessarily excuse historic deficiencies, it shows good faith on your part. This exercise can also reveal if you're paying for more licences than you need: if your pre-audit reveals that that's the case, terminate them.

Even if you're not currently aware of any planned audit, always remember that you may not get much notice of an audit being scheduled, and you could be selected for inspection even if you're doing everything right. It's best not to leave your preparations until you receive notice of the audit; keeping your records up to date over time will be less work, and less likely to result in errors, than compiling them in a frantic short-term scramble.

Disinformation management

If someone's spreading lies, don't despair – Steve Cassidy looks at how businesses can respond to the fake news threat

Disinformation seems to be everywhere! Is it really something my business can "manage"?
The honest answer to that is "partly". Disinformation is a broad idea, and while there are steps you can take to manage many aspects of it, the overall threat is slippery to define and counter. The term generally refers to incorrect information that is knowingly fabricated and spread – as distinct from misinformation, which may simply be mistaken. Intentional or not, though, it can be difficult to trace and respond to, and its impacts can extend both inside and outside of an organisation.

Look, I need practical action here, not philosophical commentary.
I know you do – but it's important to start by understanding what we're dealing with. A lot of disinformation is not spread with wholly malicious intent: our insatiable human need to share gossip means a scandalous claim can spread like wildfire across social media, passed along by credulous sorts who might not be entirely scrupulous about fact-checking, but aren't intentionally setting out to actively harm your business, or anyone else's.

Okay, sure. But the question remains: what can be done?
Well, let's start with some basics. The first question is, where is your online disinformation coming from? The first step towards shutting down disinformation is identifying its source – or, perhaps more realistically and usefully, its intent. Often, the motive may be commercial: in the business world there's a lot of jostling for the top slot on the first page of Google's search results, which can greatly affect your commercial reputation and success. "Reputation recovery" projects typically involve putting out public rebuttals while taking legal action to shut down defamatory claims – but you may not need to go that far. If you simply present some actual, genuine, well-keyworded documents online and let the search robots find it, you can sideline the bad guys (and the well-meaning rubes) by legitimately outranking them.

Isn't there a proper IT solution to this problem? Can't my security software help?
I mentioned that disinformation can have impacts inside an organisation, and the big one is via phishing – forged emails from faked addresses, with bogus attachments that contain malware. Sophisticated attackers may even use AI impersonation techniques to present interactive, real-time communications with an impostor masquerading as senior management. This is an area where your software can help, by flagging up suspicious messages and content – but training can make a big difference, too.

Is there something we should specifically be telling staff to do?
Frankly, I'd advise you keep it simple. Present the concepts and jargon, so everyone understands what's at stake, but focus on scenarios such as dealing with a mendacious post on social media, or a suspicious email from an unexpected quarter. The more technically interesting the attack method, the less likely your workers are to come across it.

But there's no magic bullet that can protect us from fake news?
I'm afraid not. And if some salesman tells you otherwise, they're assuming you don't understand the subject – which is a big red flag for proceeding with them. Disinformation isn't limited to the online supercriminals: even humble salespeople could be feeding you tall tales, to nobody's advantage but their own.

You catch more flies with honey

One of my older clients suffered for many months with a disinformation problem. They were being constantly misrepresented in an industry forum; one might have strongly suspected that the culprits were commercial rivals, though that was hard to prove.

Rather than blundering in with threats and demands, we responded positively. We went through all the genuine feedback his business had accumulated on various review sites – short things such as "quick service, good bargain, would trade again" – and built a very sparse extension to his company website that broke out more than 100 of these reviews onto individual web pages, each with a link back to the original post on the originating site. Suddenly, those 20 or 30 negative comments on a single forum were outranked by over 100 glowing testimonials, and pushed down to about page three of the Google search result listing.

The best part of this was that it required no engagement with the bad guys, nor even any investigation of who they were. All that was needed was a clear, informed view of where people realistically get their opinions from. You can pre-emptively protect yourself in a similar way, by ensuring you're posting and sharing plenty of positive, search-friendly content.

Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

"I can't afford for this to go wrong, and wrangling a cloud server is a level of trust that makes my toes curl"

Jon gives a long, hard stare to Microsoft's licensing costs, Synology's support for third-party drives and a network cable that costs £3,250

Sometimes my head goes into a spin when thinking about all of the weekly grind of updates, licensing renewals and so forth. It's easy to let things slip, especially when I need to buy some licences for the lab. It can be hard to claw back a licence renewal when it pops up on its annual payment, and the product on which the licence was activated is long gone.

Microsoft Office 365 has been a mainstay of the lab since it first appeared. The bundle cost, especially for home users, is exceptional value. I know that Microsoft recently increased the price to cover Copilot costs, but my unfashionable view is that a price rise of a moderate lunch and pint of beer on an annual licence isn't really excessive. Of course, scaled across hundreds of millions of users, it certainly helps the Microsoft bottom line.

Since Microsoft first bundled Office 365 with server side capabilities, I've been using E3 licences. These were near the top of the pile back then, and gave me Exchange Server hosted in the cloud. This was my primary need, along with the desktop Office licences, because I wanted to stop using on-premise Exchange Server. I had run Exchange since the first beta, but the hassle of keeping the server going with all the updates and so forth was too much like hard work.

By contrast, Microsoft's in-cloud solution just works. You can run it in a hybrid mode, with a mix of on- and off-premise servers, but the cloud-only solution has been my preferred choice for years. It's never gone down and I've never lost data on it. Which isn't to say that I trust it; that's why I used the excellent free Active Backup for Microsoft 365 platform (**tinyurl.com/370activebackup**), which runs on the Synology NAS. This logs into main administrative Office 365 account and then downloads all of the content to the local NAS. I'm talking OneDrive, Mail, SharePoint, Contacts, Calendar and Teams information, all in real-time, updating every minute or so.

In case of disaster, Active Backup for Microsoft 365 lets you drill into all of the downloaded data. It's possible to find a particular email in an inbox, for example, and you can push the data back to the cloud if needed. I'm happy just knowing that I have a full local backup of my cloud Exchange Server installation, and that I can easily access the contents. Regular readers will appreciate that I'm very cautious about data, subscribing to the mantra, "There are two types of people: those who have lost data, and those who haven't... yet".

I run this process independently on two Synology NAS platforms to get two copies. And then I regularly export each mailbox to EML and PST file formats too. Of course, all of this goes into the regular backup and archiving process, including sending the data to two cloud backup storage facilities. Paranoid? Yes, I am. Who told you?

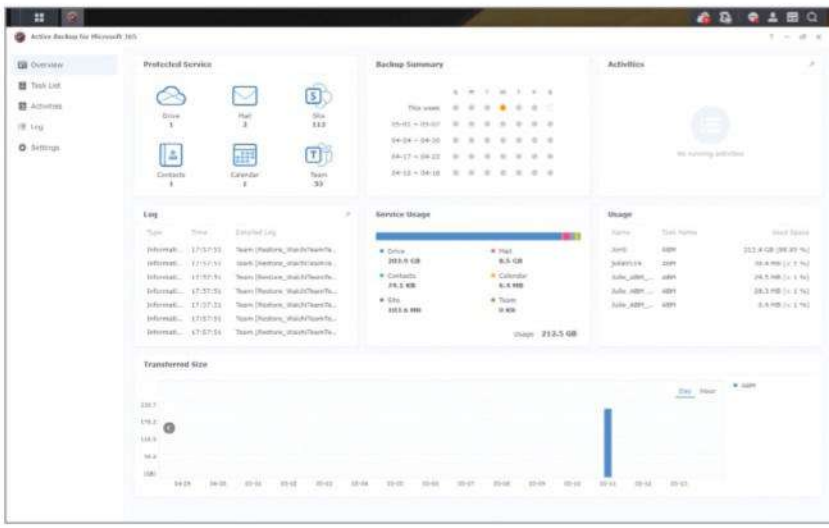
As a solution, my Office 365 package is working just fine. I somewhat hate the user interface when you start digging in, especially the Exchange Server component. This provides a level of complication that's probably fine for a global corporation with a large IT team but is simply beyond scary for anyone in the small business scale of user.

Anyway, the whole reason I raise this as a topic is that I was looking at the licensing costs, and I have 13 E3 licences that cost £22 per month,

Jon is the MD of an IT consultancy that specialises in testing and deploying kit
@jonhoneyball

£9.60 user/month, paid yearly
Annual subscription–auto renews[1]
Price does not include VAT.
Buy and download
Or
Try free for one month
See trial terms[2]
Or buy for £11.52 per month with a monthly commitment

ABOVE The Microsoft 365 Business Standard licence has everything I need for £9.60 a month



BELOW Synology's Active Backup for Microsoft 365 gives me peace of mind

Jon Honeyball
Opinion on Windows, Apple and everything in between – p110

Lee Grant
Tales from the front line of computer repair – p113

Dr Rois Ni Thuama
Risk analysis from our expert in cyber-governance – p116

Davey Winder
Keeping small businesses safe since 1997 – p118

Steve Cassidy
The wider vision on cloud and infrastructure – p120

plus VAT. That comes to £343.20 per month including VAT, which, at the end of the day, is quite a lot of money.

I looked at the Office 365 web page and found that the Microsoft 365 Business Standard licence would do all I need. It has all the desktop apps included, so I'm not forced to use the cloud versions. It also includes Exchange Server, SharePoint, OneDrive and Teams. And it costs £9.60 per month plus VAT, which is a hefty drop from the £22 I'm paying now. If I could manage without Teams, then the price drops to £7.90 per month plus VAT.

It's not quite that simple, of course, because all those "per month" prices assume you're willing to pay for a one-year licence up front. If I want to pay for it monthly, the cost is £9.48 per user per month, plus VAT. Still, that's a lot less than the £22 per user per month at the moment.

But wait, for it's not quite an apples for apples comparison. I noticed that the amount of storage in Exchange Server drops from 100GB to 50GB per user, which I couldn't see being a problem until I checked in the management console and found that Andre's inbox was 60GB. It only got so big because I set up a copy inbox folder and a rule to take a copy of everything into that folder, as a live backup in case he deleted something by mistake. So that inbox is twice as big as needed, and I can get rid of this copy folder with no worries, especially as closer investigation revealed 225,000 emails, along with their attachments. I think "oops" is in order. It's a historical thing that has just continued in the background and is in need of a spring-clean. This would easily get the mailbox down to a manageable size that would fit into the new 50GB limit.

My next worry was this: how do I downgrade the licences? Well, I went into online chat and spoke to some Microsoft support people. They maintain that I just need to buy the right number of Business Standard licences, which is 13. Then to assign them to the 13 accounts. And finally to remove the E3 licence from the account. They swear blind that all of my email and storage will be just fine, and it will continue to work.

I haven't done it yet, but will summon up the courage soon and report back. Can you now see why I have first covered how I have a backup and archive of all the emails? I can't afford for this to go wrong, and wrangling a cloud server is a level of trust that makes my toes curl.

Synology changes

Synology, my long-term preferred purveyor of network attached storage, recently published a statement about the forthcoming 2025 versions of its products. And this has been ruffling a lot of feathers on the InterTubes.

"For users, this means that starting with Plus series models released in 2025, only Synology's own hard drives and third-party hard drives certified to Synology's specifications will be compatible and offer the full range of features and support," reads part of the statement (read the full thing at **tinyurl.com/37osynology**).

The Plus series range is Synology's middle tier. It has rack-mounted servers for the high end, and cheaper products aimed at simple use cases. But a decently specified Plus series box can do a lot of work, and I have over half a dozen of them, holding around a quarter of a petabyte of storage distributed over several physical locations.

Synology introduced its own-brand hard disks a few years ago, and made them mandatory for the then-new high-end boxes. It caused a ruffle then, but mostly among the chattering classes who wouldn't have bought into that expense of server in the first place. A first-glance reading of the statement suggests that the same restrictions are coming to the mid-range Plus series, or so the commenters shouted. However, it's worth reading Synology's statement a little more carefully:

ABOVE **Changes are afoot for Synology's mid-range Plus series**

"I haven't done it yet, but will summon up the courage soon and report back"

"The use of compatible and unlisted hard disks will be subject to certain restrictions in the future, such as the creation of pools and support in the event of problems and malfunctions caused by the use of incompatible storage media. Volume-wide deduplication, lifespan analysis, and automatic firmware updates of hard disks will only be available for Synology hard disks in the future"

Let's unpack that. Storage pools are something I simply don't use, so I'm not bothered about that. Support in the event of problems and malfunctions? Well, I expect Synology to still provide support on the NAS itself, but its support for third-party drives themselves has always, by its nature, been limited. Volume-wide deduplication is a feature that has only been on the high-end devices up till now. It's very intensive on both CPU and drive read/write, as it scrubs through looking for file matches.

The lifespan analysis is the key point here: if you're going to

BELOW **Synology is insisting users deploy its own-brand disks**

significantly increase the workload on the drives, then you need a better view of what's happening. Synology's own drives apparently have enhanced reporting, in a similar fashion to that found in the IronWolf Pro drives. It will be important to see if Synology artificially removes reporting capabilities from existing drives.

Firmware updates of hard disks is a topic I covered three months ago (*see issue 367, p110*), when building the Unifi NAS. Most people don't do it and view the drive as a lump brick of storage that they put into their preferred NAS storage. It is possible to update the firmware in the drive itself, but only if the NAS knows how to do that. I don't think it's reasonable to expect Synology to do this on all third-party drives, but it can be done on its own drives with its own firmware. After all, when was the last time that your Windows installation updated the firmware in the drives in your desktop computer?

Synology says that you can take a bunch of drives out of an older drive and put them into a 2025 model box, and it will still migrate and work just fine. So, with some appropriate cautions, there isn't much to see here. That, however, assumes that Synology's price per terabyte of storage for its own-brand drives is comparable to that of third parties such as IronWolf Pro, which has been my historical chosen drive. If you search around, prices are broadly similar at the moment. One final note: there will be a range of "third-party hard drives certified to Synology's specifications", but we need to wait to see what this means.

Clearly Synology has to be seen to be doing the right thing, and not trying to pull a fast one. It would kill its market quite quickly if it does. For myself, if I deploy another Synology NAS, I would probably load it up with Synology's own drives, unless IronWolf Pro appears on the approved list. Why? Because the very nature of a NAS drive is that you trust it for storing your data. And although you should never trust anything to work at any point in the future, having good reporting of what's happening to your disks is a sensible strategy.

But I would draw your attention to the "if" as part of that comment. You see, I'm having fun with the barebones storage of the UniFi NAS, and I'm more likely to buy a second one of these and use the built-in replication and backup facilities between those two devices. Synology is a solid platform, and it works well. It's just that it seems to be somewhat stagnating. Version 7 of the OS has been around for a while, and significant improvements just don't seem to be happening. There's no published roadmap to a version 8, nor any hint of what that might deliver. And its hardware is not really as cutting edge as it should be – the CPUs should be faster, there should be more RAM, and 10GbE and small form-factor pluggable (SFP) ports should be the norm. That's if you take a view where a NAS bought today should have a five- to eight-year lifespan ahead of them. There are competitors such as QNAP and various software solutions that can provide NAS-like capabilities on standard hardware, so the competition is biting at Synology's ankles.

ABOVE **The prices of third-party drives are broadly similar to Synology's prices**

"My hackles rise when I am confronted with the 'more enthusiastic' end of the hi-fi scene"

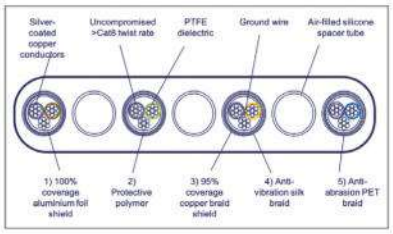
The wacky world of high-end audio

The world of high-end audio is a mystical and strange place indeed. If you want the very definition of "unfounded claims and technical woo-woo" then go to a hi-fi show. Now, before I go any further, I should point out that I have worked in this space for 40 years. We have an IEC specification listening room and proper listening panel capabilities. Not to mention the finest audio test equipment on sale from companies including Audio Precision and Spectral Measurement.

Despite all this technology, the simple reality is that we have no real idea how the massively non-linear transducer called the ear works when coupled to a supercomputer called the brain. So I am never surprised when something is clearly audible but essentially impossible to measure because the measurement capabilities out there are not measuring what we hear, and in a way that we hear it.

My hackles rise, however, when I am confronted with the, shall we say, "more enthusiastic" end of the hi-fi scene. To set some background, the rise of streaming services has seen the introduction of computer networking into the hi-fi space. To say the hi-fi industry does a bad job of explaining stuff would be an understatement.

BELOW **The Reiki Audio Ethernet cable: yours for just £3,250**



ABOVE The cable apparently has a "revolutionary audio-optimised architecture"

From the Audio Engineering Society down to trade bodies to dealers, the lack of understanding and explanation of the basics is worrying. And this allows for some quite bizarre products to be released.

For example, how about an Ethernet cable that costs £3,250 minimum? You'll find it at Reiki Audio (**tinyurl.com/370reiki**), along with this claim: "Our reference network cable uses a revolutionary audio-optimised architecture to set a new benchmark for the sound quality available from networked audio."

It goes on: "No other network cable looks like it; no other network cable sounds like it." And then: "Diving deeply into every single aspect of cable design, we concluded that the physical structure of network cables, whether Cat-compliant or audiophile or both, essentially limits their audio performance." I'm unsure why I would want a non-Cat compliant Ethernet cable, but no matter.

There is the not small issue of cost. That £3,250 price I mention is for one metre; two metres is £4,650. Now, I'm not going to get involved in the somewhat cheap nonsense of ridiculing the price. You're either prepared to pay or you're not. No-one is forcing you. And who knows what Reiki Audio's bill of materials is? I suspect there's a robust margin, but who can tell?

The problem is that this is a classic clash between two worlds. I'm somewhat old-fashioned and want to see the Ethernet side of things properly explained to justify anything more than a standard Cat6 cable. What happens to the error rate? What about EMC pickup? All of those very boring networking items should be addressed, but no-one appears to want to take on that level of produce explanation and justification.

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LEE GRANT

"Any company pushing its eco-credentials without facilitating fixing is guilty of greenwashing"

As Acer loses another fan and Microsoft users move backwards, Lee explores the risks of exploding webcams

Acer is a firm that is extremely proud of its green initiatives and accreditations. It's listed as one of *Time* magazine's most sustainable companies, and its other ESG focused awards are numerous. In a tech sector desperate to convince investors and shareholders that it's "doing its bit" to prevent the world from burning down, Acer consistently makes all the correct noises.

Meanwhile, on the other side of the world, a frustrated Acer laptop owner is explaining to me where Taiwan's finest can shove its eco-credentials.

One fan inside Jordan's Acer Predator laptop blew its bearings and became intolerably noisy. Headphones made this manageable when playing games, but Zoom and Teams calls were impossible, which was a problem for remote working.

The Acer Predator had been an expensive purchase. A 2022 Smith-Gen i7, 32GB of RAM, 1TB SSD and RTX 3070 graphics had all been squeezed into a 16in chassis. Jordan works in the financial sector, so the Predator had been a strategic spend to invest in a machine with a substantial specification. After all, the more you spend, the longer the machine will last, right?

Jordan arrived in the shop seeking help. I made some notes and, after a few days of trawling suppliers, I'd found no parts. Given the urgency of the repair, I told Jordan to contact Acer for a repair quote as it would have the part and it may be a faster route to a repair.

Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
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"After all, the more you spend, the longer the machine will last, right?"

Here at *PC Pro*, we celebrate the manufacturers that are genuinely trying to differentiate themselves in the market by offering genuine repair solutions. Repair and reuse are vital components to a circular economy, so any company pushing its eco-credentials without facilitating fixing is guilty of greenwashing.

Jordan contacted Acer, who pointed him towards its UK repair partner Laptronics (**laptronics.co.uk**), a third-party repairer that handles repairs for many OEMs. Jordan emailed Laptronics, who responded: "We do not have any stock and neither do Acer! :(Apologies." Desperate for a solution, Jordan enquired about the part's ETA or any other advice on how to get the laptop fixed. Laptronics replied: "Unfortunately, as Acer is completely out of stock, there is no way we can repair a broken fan without the part! :(Really am sorry, I do hope you find a solution."

I don't envy Laptronics' position. Not only does it seem that it couldn't get parts from Acer, but it had to deliver the bad news. Acer gets off the hook twice. I've been put in this awful position countless times and it's utterly avoidable if Acer (2024 turnover: NT$264.71 billion, a 9.7% increase year on year) was genuinely eco-minded enough to reduce its bottom line to stock £30 parts.

At that point, Jordan owned an expensive Acer laptop that was useless for the task. Thankfully, there is a happy end to this story.

BELOW Laptronics was left to deliver the bad news from Acer

Not Acer's biggest fan

Whilst Jordan was getting nowhere through official channels, I found a US-based reseller offering "genuine" Acer parts. I asked the right questions and got the right

answers, so the consensus was to get the parts onto the workbench and see how "genuine" they were. After a few weeks, they arrived in a condition I would expect of OEM components, in a static bag locked with branded seals. Comparing them to the originals, I couldn't find any differences to the factory-fitted components. If they were copies, they were superb.

ABOVE **Getting hold of a replacement fan from Acer was impossible**

It won't surprise you to know that when Acer built Jordan's Predator, repair wasn't on the list of priorities. Even a simple task such as adding more RAM (64GB max) or increasing storage requires a full motherboard removal. To add to the treacherousness is a 4mm ribbon cable that runs from the underside of the machine to the top, invisible enough to be accidentally ripped off. Normally, laptop fans are held in with a few screws, easily accessed once the machine is open. This makes replacement straightforward and lowers the risk of damage. Some increase the difficulty by hiding the fan mountings. Acer's designers have seen this, then said, "Hold my beer" and created a Predator fan mounting system that's screwed in from the top and the bottom.

To compound this misery, Acer doesn't provide repair documentation for the Predator. It does produce an Environmental Report (**tinyurl.com/370report**) that lists the relevant environmental metrics to earn a shiny badge to show investors, but won't help anyone fix anything. HP, Lenovo, Apple and Dell have, to varying degrees, improved their repair documentation. Acer is lagging behind.

The end of the story is that the replacement parts worked well. There are three fans in the Predator and, while it was in pieces, I replaced them all. Jordan could return to working normally, but Acer lost a future customer and it's no surprise. Acer would be hard-pressed to make this machine more complicated to repair. The inability to supply parts or documentation demonstrates that repair was not a consideration for this range of Predators. It really is a poor show from one of the supposed global leaders in tech sustainability.

Tipping point

If you've never encountered the Van Westendorp Price Sensitivity Meter, it's a tool that identifies a range of price points that are psychologically critical to your customers. In short, it can indicate how much they're willing to pay for a product, and from what I'm seeing in the shop I think Microsoft 365's recent price increases have smashed through the tipping point.

Here is a brief recap. Microsoft has upped the subscription price for Office Home and Family by 30 to 40% so users can utilise new Copilot features (*see issue 367, p26*). There will be some of our readers who won't mind paying the extra as Copilot is a useful addition to their workflow, but that isn't the case for a handful (and increasing) of my customers. The price rise has made them consider if they need a subscription at all.

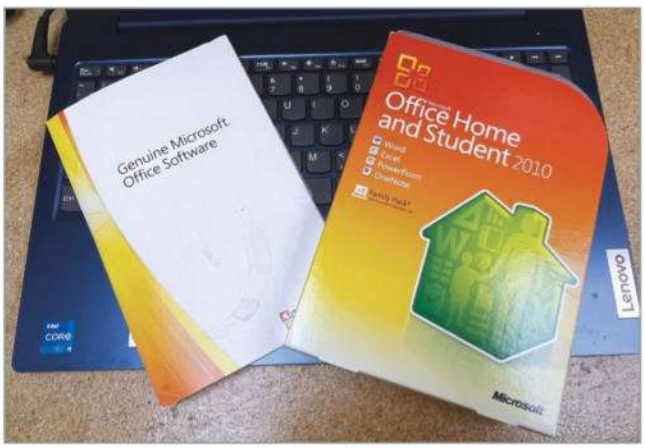
Aside from pricing, there was dismay that Microsoft Publisher will be culled in October 2026. It's a stretch now to imagine, but back in the early 2000s, Publisher was a driver in Office retail sales. At the time Publisher was taught in schools and, as Office Home & Student only had Word, Excel, PowerPoint and OneNote, families splashed out several hundreds for Office Pro so homework could be completed. Somehow Publisher triumphed within the consumer DTP space, whereas arguably better programs such as Macromedia Freehand, Serif PagePlus and CorelDRAW failed.

"The price rise has made them consider if they need a subscription at all"

Publisher is one of the Office apps that has largely been neglected by Microsoft in recent years, so this news isn't really a surprise. What many Publisher users haven't realised, and why I'm mentioning it here to help spread the word, is that Microsoft isn't only ending support for Publisher, it's killing it off. According to the press release (**tinyurl.com/370publisher**), "Microsoft 365 subscribers will no longer be able to open or edit Publisher files in Publisher". So even opening documents as read-only won't be possible.

Microsoft recommends using Word as a Publisher alternative, which is like telling someone to trim their toenails with a chainsaw. Though Word's handling of DTP-style documents has improved, I'm reliably informed it remains an unpredictable process. One of my customers is a hugely successful writer of textbooks and, for reasons they abhor, one of their publishers insists on receiving the manuscript in Word. One wrong click while re-positioning an image, and the margins explode. I'm interested to know if Tim could produce *PC Pro* in Word. Let's ask him and we can all find out together: "Hey, I once created a magazine in AmiPro. But I think the designers would go on collective strike, so in reality no, unless you're a fan of 1990-era newsletters." Who said a print medium can't be interactive?

We know many small organisations, particularly in the volunteer sector, continue to use Publisher because they always have. It works and they've got better things to do with their time than learn another package to get the same result. If this sounds familiar, then put "migrate from Publisher" on your to-do list. If you're reading this after October 2026, then LibreOffice Draw will open .pub files.



BELOW **Is Microsoft 365's price rise an increase too far?**

I'm keen to know if Microsoft will push an update to uninstall Publisher from PCs when the time comes. If that sounds a little far-fetched, then turn on a new laptop and look for Outlook (Classic) within the pre-installed 365 trial. I haven't got to the bottom of this yet, but during several recent laptop setups I've wanted to import the client's legacy Outlook data and found that the program isn't there. The "new" Outlook for Windows is present, but that's no use if I've

got a 20GB PST needing re-homing. One solution requires uninstalling the pre-loaded Office packages (of which there may be many language variations), restarting the machine and then downloading the setup file from **office.com**. The writing is on the wall for Outlook (Classic), but probably not in a Publisher format.

The Great Microsoft Exodus

Some customers are truly fed up and are taking matters into their own hands. They've thrown open the cupboards, found their old copies of Office 2003, 2007 or 2010, then asked me to install them. Many are genuinely angry. They've realised that the subscription benefits of 365 have never applied to their use and they've been forking out for software that did nothing better than the stuff they'd bought a decade earlier. "Hoodwinked" was how one lady described it. If this is giving you food for thought, then officially only Microsoft 365 is supported by Microsoft, but much older versions install and work well on Windows 11.

The sound of breaking Windows

If you missed episode 734 of the award-ignored *PC Pro* podcast, go back and listen to the discussion about EuroStack, a pitch document which states how the European Union could become technically self-sufficient and move away from US-based software, storage and devices. This desire has been echoed by a few customers who feel compelled to do similar. Some want to talk about a complete defenestration to Linux (*see Nik Rawlinson's fabulous group test in issue 367, p78*) while others have decided that Satya Nadella will not rule their technical destiny and want to run Windows 11 on unsupported hardware.

I applaud the spirit of these customers and try my best to support them as much as possible. In our shop, I'm currently running two Windows 11 machines on unsupported hardware (neither goes anywhere near customer data) and can report no problems at the moment. However, Microsoft knows what I'm doing. During the Windows 11 installation process, a message appeared: "Installing Windows 11 on this PC is not recommended and may result in compatibility issues. If you proceed with installing Windows 11, your PC will no longer be supported and won't be entitled to receive updates." Both statements are perfectly true, giving me fair warning of my actions.

The third message was pure scaremongering: "Damages to your PC due to lack of compatibility aren't covered under the manufacturer warranty." Message understood, Microsoft. If my webcam explodes due to an incompatible driver, I'll be sure not to claim on the long-expired warranty about the fragment of lens protruding from my forehead.

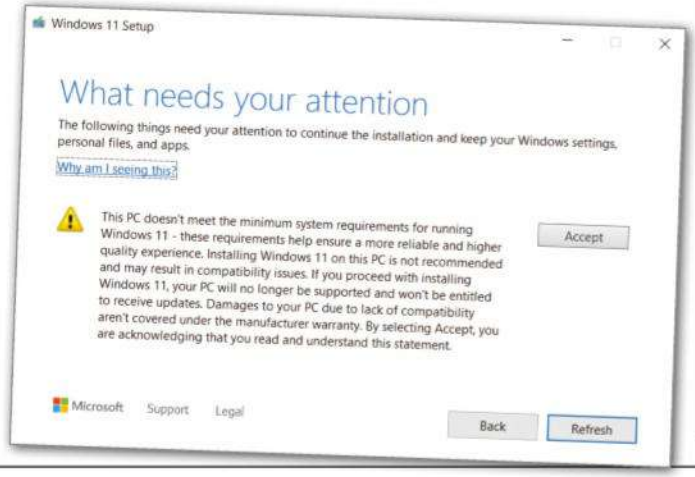
Ready to print?

It's always nice to write a story about a tech manufacturer that considers their customers and creates products that help to troubleshoot inevitable problems. Sadly, this isn't one of those stories. It's the usual guff about mass-produced consumer electronics designed by people who have never met an actual customer and have no comprehension that their products could be used in ways that aren't covered in the manual.

ABOVE Plus point: the yellow cartridge turned the printer into a ReadyPrint device

"If my webcam explodes, I'll be sure not to claim on the long-expired warranty"

BELOW Microsoft gives fair warning of Windows 11's potential compatibility issues


Windows 11 Setup
What needs your attention
The following things need your attention to continue the installation and keep your Windows settings, personal files, and apps.
Why am I seeing this?
This PC doesn't meet the minimum system requirements for running Windows 11 - these requirements help ensure a more reliable and higher quality experience. Installing Windows 11 on this PC is not recommended and may result in compatibility issues. If you proceed with installing Windows 11, your PC will no longer be supported and won't be entitled to receive updates. Damages to your PC due to lack of compatibility aren't covered under the manufacturer warranty. By selecting Accept, you are acknowledging that you read and understand this statement.
Accept
Microsoft
Support
Legal
Back
Refresh

Sarah arrived in our shop with an Epson XP-2150 saying that it wouldn't print and kept displaying a message she didn't understand. Epson's message said "The ReadyPrint service requires your printer to be connected to the internet", which was true, but unexpected. Sarah didn't use ReadyPrint, Epson's ink-subscription service, and her printer connected with USB. Epson's Status Monitor also didn't give any clues. It showed four usable 603XL cartridges were installed, with not a hint of what the problem was. Sarah had mentioned that the problem had occurred after she'd changed the ink cartridges, so I removed hers, installing a spare set of Epson 603s. The message went away.

Curiously, Epson's Status Monitor looked the same. Four usable 603 tanks installed. I spotted the real problem when I re-installed Sarah's cartridges. The sticky label on the black, magenta and cyan tanks was 603, the yellow was 603+. The "+" represents a ReadyPrint subscription cartridge, which Sarah had accidentally bought from Amazon (thanks for shopping locally). By installing a "+" cartridge, the Epson printer becomes a ReadyPrint device without any user verification. In error cases like Sarah's, the machine stops working but doesn't even hint as to why. The "+" designation doesn't appear within Epson's Status Monitor. Surely a missed opportunity to communicate useful information. The solution was to swap the "+" tank for a standard yellow. ReadyPrint turns off and all is well with the world once more. If anyone from Epson wants to meet a real customer, feel free to drop into the shop and don't forget the biscuits.

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ROIS NI THUAMA

"I'm not claiming to be a prophet. I merely speculated wildly and, against all odds, hit the mark"

After urgently calling for anti-drone missile technology, Rois is pleased to discover that the MoD has heeded her advice

Nobody likes a know-it-all. Less appealing still is someone who actually says "I told you so." But when someone unburdened by any measurable technical expertise happens to blurt something out on a podcast (*PC Pro* podcast episode 725, viewable at **tinyurl.com/370pod725**), and it later turns out to be eerily on the money, well – how can one *not* gloat just a little?

You see, some time ago I asked, possibly with dramatic arm gestures, "Surely to God we have the technology to knock things out of the sky with a beam?" I wasn't proposing death rays – although who among us hasn't secretly wanted one? – but something a bit more precision-engineered. It turns out, we kind of do.

Now, I'm not claiming to be a prophet. I merely speculated wildly and, against all odds and reason, hit the mark. Besides, I wasn't the first to imagine such a thing. Let us not forget that seminal moment in the late 1970s when Colonel Steve Austin – yes, *that* Six Million Dollar Man (adjusted for inflation, a very reasonably priced £36 million) – helped exonerate a test pilot whose aircraft was mysteriously downed. The culprit? A disgruntled Navy scientist with a beam that could zap the electrics in a plane or Jeep. Science fiction? Not any more.

RFDEW: it does what it says on the tin

Fast-forward to 2025 and the Ministry of Defence, in collaboration with the private sector, has unveiled a frankly impressive anti-drone system. For a mere £40 million – the same cost, incidentally, to rebuild Steve Austin. Coincidence? I don't think so. For that same tidy sum, the MoD has developed a Radio Frequency Directed Energy Weapon, or RFDEW. No, it's not the catchiest name – unlike laser, which somehow made the leap from acronym to everyday lingo – but I like it. It's honest. It does exactly what it says on the tin.

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"Here's the part that really caught my eye: each RFDEW shot costs just 10 pence"

And here's the part that really caught my eye: each RFDEW shot costs just 10 pence. That's not a typo. Ten. Pence. Per. Shot. According to the MoD, "the RFDEW beam is a significant cost-effective alternative to traditional missile-based air defence systems, capable of downing dangerous drone swarms with instant effect."

Better yet, it can be operated by just one person – which, in itself, helps keep costs down. According to Sgt Mayers of the 106 Regiment Royal Artillery – who had the honour of being the first British soldier to bring down drones using the weapon – "We found it quick to learn and easy to use." Sounds just about my speed when it comes to technology. If you can point and zap without needing a PhD in quantum physics you've got my attention.

If I buy a printer, it's because I want to print. Similarly, if I was to buy a beam weapon designed to frazzle drones, it's because – well, you get the picture. I would want it to frazzle drones.

So why do we need anti-drone technology? Quite a few reasons, actually. Let's take it from the top.

Anti-drone tech for the win

Drones aren't just for aerial selfies and delivering overpriced lattes any more. They've become handy tools for criminals, particularly when it comes to smuggling drugs and weapons. And if we can't control the skies above our highest-security prisons, that's not just inconvenient: it's a serious threat to national security.

In January this year, the chief inspector of prisons called for urgent action to deal with the rising number of drones delivering contraband to inmates in Category A prisons. That's not a minor issue. These are facilities that hold some of the most dangerous individuals in the country – people officially labelled as high-risk.

And of course, there was the incident in California that first prompted my on-air outrage about drones during the *PC Pro* podcast. A Super Soaker firefighting plane was grounded after being struck by a drone in January. This happened in the middle of a wildfire response effort within an area where unauthorised flying (including drones) was expressly forbidden. It's a miracle no-one was killed. When you're trying to save homes and lives, the last thing you need is to delay emergency air drops because someone fancied getting a better shot for their Instagram story. We simply can't afford to put first responders in any more jeopardy than they're already in.

And then, selfishly, there's me. Two things you should know: (1) I live near the mountains; and (2) I also happen to live directly on the regular low-level flight path of the RAF's Hawk and Texan trainers in an area of intense aerial activity.

While I've (thankfully) never needed mountain rescue, I'd quite like to believe that if I ever did need pulling off a peak, drones wouldn't be cluttering the skies and blocking the

RIGHT Unmanned drones are being deployed in conflicts around the world

route for the rescue helicopter. Likewise, keeping the airspace clear for our pilots and their instructors seems like a pretty reasonable request.

And of course – oh yes – I'd also really prefer to fly off on holiday without having to knock back Xanax like they're Tic Tacs because someone wants footage for their TikTok.

The legal side of drone use is... well, let's call it a work in progress. While the technology has advanced rapidly, the enforcement has sometimes lagged. But recent cases suggest things might be turning a corner.

Take the Wirral man who, in March this year, was found guilty of flying his drone in breach of height and distance restrictions while filming Everton's new Bramley-Moore Dock stadium. On another occasion, he flew it nearly 300ft above the legal height limit in Anglesey and sent it 2.39km away from his take-off point – well beyond the range where he could maintain visual line of sight, which is very much a no-no under current recreational drone rules.

He was convicted on four counts – two for flying above the legal height, two for letting his drone disappear over the horizon – and was handed a fine of £2,890. Not nearly enough, in my opinion, for treating what is essentially an airborne liability like a toy. But it's a start. At the very least, it shows the courts are beginning to take these violations seriously.

Contrast that with an earlier case, where a 37-year-old man strolled away from Leamington Spa Magistrates Court after committing 15 dangerous drone offences – four separate unsafe flights between December 2016 and January 2017. His total penalty? A £259 fine, a £30 surcharge, £185 in costs and a confiscated drone. That's less than the cost of a decent pair of noise-cancelling headphones.

And yet the law *does* have teeth, at least on paper. Section 240 of the Air Navigation Order 2016 clearly states that endangering the safety of an aircraft is a criminal offence. On conviction, a court can impose a fine, a prison sentence of up to five years, or both. Now that sounds more like it.

As the Civil Aviation Authority puts it, in terms both clear and blunt: "It is totally unacceptable to fly drones close to airports and anyone flouting the rules can face severe penalties including imprisonment." Let's hope that "can" soon becomes "will" before someone's hobby and a moment of inattention collide in mid-air with something far bigger and faster.

ABOVE **Drones are a real and increasing threat to aircraft**

All of this assumes the operators in question are simply careless, rather than malicious. But that benefit of the doubt becomes harder to offer when you consider reports of mysterious drones operating over US Air Force bases here in the UK. That's not a case of poor judgement. That's something else entirely.

Drones in warfare

Beyond the local and domestic, drones are now playing a starring role on the international stage: in the grim theatre of modern warfare. They're used for surveillance, reconnaissance and, increasingly, for direct attacks.

Ukraine reportedly defended itself from 18,000 drone assaults last year alone. That's not just a number – it's a reminder that the skies have become the new frontline. Meanwhile, Russia has weaponised drones to devastating effect, launching strikes that have killed civilians and destroyed markets, schools and hospitals. Roman Kostenko, chair of Ukraine's Defence and Intelligence Committee, estimates that drones are now responsible for up to 80% of wartime casualties. That statistic alone is enough to make any talk of "hobbyist misuse" seem like a quaint problem from a much simpler time.

And yet, all of this brings us right back to Steve Austin.

In that classic *Six Million Dollar Man* episode, Steve is riding in a Jeep with the test pilot when the rogue scientist unleashes his prototype beam weapon. The result? The Jeep's electrics go kaput, leaving our heroes stranded. Now, you may reasonably ask how the beam managed to knock out the crude circuitry of a Willys Jeep (long before the adoption of advanced engine management systems) while leaving Steve's cutting-edge bionics unaffected. You could be on to something.

"The beam that can protect us today might be the same one we'll fear tomorrow"

BELOW **We have the technology: Steve Austin, way ahead of the times**

Because, even with today's very real RF-directed energy weapons, there's one lingering concern: area of effect. A beam powerful enough to fry a drone's electronics from a kilometre away might also scramble, say, nearby medical devices, aviation systems or even friendly assets. A wide cone of interference – what the military might politely call a "blast radius" – could, in the wrong setting, create more problems than it solves.

As I'm fond of saying: but wait, it gets worse.

While the RFDEW is undoubtedly a formidable tool – one that marks a major step forward in defence technology – it would be naive to assume it will remain solely in our hands, or even those of our allies. History doesn't work like that. Once a weapon exists, it rarely stays exclusive for long. From there, it's a short and uncomfortable mental leap to imagine how such power might be used by actors who care not a jot for human life, international law or even basic accountability.

The beam that can protect us today might be the same one we'll fear tomorrow. In a world where drones are cheap, accessible and increasingly weaponised, and where the line between science fiction and battlefield strategy is growing ever thinner, the question isn't just what we can do – but who else might be watching and waiting to do it too.

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DAVEY WINDER

"I've done a bit of deep-diving myself and found some technical stuff that the FBI didn't"

Davey indulges in time travel with hackers who have earned the ire of the FBI

Wouldn't it be nice to live in a world where things weren't quite so crazy? No, I'm not talking about the fascinating real-world cartoon that is President Orange and his sidekick, Space Karen, but rather one where ransomware actors weren't still a massive threat to your networks, data, reputation and bank balance. But here we are.

Despite FBI disruption, hair-pulling and squabbling within criminal groups (Black Basta I'm looking at you) and a generally improved defensive posture against ransomware, the threat is not only evolving but surging.

One report, from a group of threat intelligence experts at Ontinue, revealed a 132% increase in ransomware attacks in quarter one of the year compared to the quarter before. This comes at the same time as the amount of money actually being paid to scumbag attackers dropping by 35%, no doubt in response to a harsher regulatory and legal playing field. When I spoke to Casey Ellis, the founder of the Bugcrowd bug bounty hacking platform, he warned that "the ransomware business model is an arms race, and threat actors are nothing if not adaptable." Sadly, he is far from being wrong.

Ransomware as a service

Which is where Medusa enters stage left. As well as the ransomware threat seeing a bulk shift from network lockdown to data exfiltration, there has been a shift behind the scenes in the way the criminals operate.

One of the biggest evolutionary moves has been towards providing ransomware-as-a-service models. To explain, the more "traditional" model involves the developer (and therefore the brains behind the operation) taking a slice of the victim payment pie while the affiliates who do the attack donkey work grab an even bigger chunk of the ill-gotten gains.

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"Despite FBI disruption, the threat is not only evolving but surging"

The RaaS approach is a development of this straight affiliate process. Although there are many variations, a RaaS platform will charge a hefty monthly subscription fee that gives the user access to the malware and, more often than not, a sophisticated management console that can show the status of attacks and how well they're doing. Some variations include paying a one-off licence fee and, harking back to where all these RaaS operations started, the affiliate profit-sharing revenue model.

Offering ransomware for rent is so attractive for the same reason that phishing or infostealing malware is so popular among the criminal community: it doesn't require a technical genius to create and deploy. All that's needed is criminal intent and a desire to make money without having to do an honest day's work.

Medusa, as you have probably guessed by now, is a RaaS platform. It first appeared, as far as anyone can tell, way back in 2021 and has since been hugely successful. So successful that an FBI investigation has determined that there have been at least 300 victims who have fallen prey to the attackers since then.

If you're getting ransom payments out of ten or so organisations every month for four years, you're almost certainly making enough profit to be considered a big-time player. Which is why the FBI threw resources into a full-blown investigation into the Medusa operation, revealing what it called a "dossier of tactics, techniques, and procedures, indicators of compromise, and detection methods associated with the threat actors".

This, in turn, has led to the FBI issuing a public cybersecurity advisory AA25-071A that takes a deep dive into the Medusa operation and includes a whole bunch of mitigation recommendations, which I will return to later. But first, I've done a bit of that deep-diving myself and found some technical stuff that the FBI didn't. Technical stuff that is, at the very least, hugely interesting to those with a security geek mindset.

JOINT CYBERSECURITY ADVISORY

TLP:CLEAR

Product ID: AA25-071A

March 12, 2025

Co-Authored by:

MS-ISAC Multi-State Information Sharing & Analysis Center

#StopRansomware: Medusa Ransomware

Summary

Note: This joint Cybersecurity Advisory is part of an ongoing #StopRansomware effort to publish advisories for network defenders detailing various ransomware variants and ransomware threat actors. These #StopRansomware advisories include recently and historically observed tactics, techniques, and procedures (TTPs) and indicators of compromise (IOCs) to help organizations protect against ransomware. Visit stopransomware.gov to see all #StopRansomware advisories and to learn more about other ransomware threats and no-cost resources.

The Federal Bureau of Investigation (FBI), Cybersecurity and Infrastructure Security Agency (CISA), and the Multi-State Information Sharing and Analysis Center (MS-ISAC) are releasing this joint advisory to disseminate known Medusa ransomware TTPs and IOCs, identified through FBI investigations as recently as February 2025.

Actions for Organizations to Take Today to Mitigate Cyber Threats Related to Medusa Ransomware Activity

- **Mitigate known vulnerabilities** by ensuring operating systems, software, and firmware are patched and up to date within a risk-informed span of time.
- **Segment networks** to restrict lateral movement from initial infected devices and other devices in the same organization.
- **Filter network traffic** by preventing unknown or untrusted origins from accessing remote services on internal systems.

Medusa is a ransomware-as-a-service (RaaS) variant first identified in June 2021. As of February 2025, Medusa developers and affiliates have impacted over 300 victims from a variety of critical infrastructure sectors with affected industries including medical, education, legal, insurance, technology, and

BELOW The FBI has issued a cybersecurity advisory notice for Medusa ransomware

Time-travelling packers

The first bit of information, which stems from research by Elastic Security Labs, is that at least some of the Medusa ransomware campaigns have been deployed using something called HeartCrypt. Rather ironically, a packer-as-a-service.

A packer does what it says on the tin: it packs malicious code into legitimate binaries. This is a method of obfuscation, rather obviously. The interesting thing is that the HeartCrypt-packed loader in question was used alongside a revoked certificate-signed driver. In other words, this is a bring-your-own-vulnerable driver attack. The aim is to disable, or at least bypass, endpoint security protections in place. So far, so meh, I guess, until you factor in the time-travel aspect. The what now?

Yes, time-travelling hackers. This is where things get really interesting. I spoke to Boris Cipot, a senior security engineer at Black Duck, who explained how the Medusa attackers were able to abuse system misconfigurations by employing time-travel techniques to the previously mentioned certificate-signed driver.

I have already mentioned that the certificate was revoked, which would appear to be enough to set off security protection alarm bells, you'd think. Indeed, the certificate in question was valid way back in 2012 and long since expired. What the Medusa malware did was to change the system date back to a time when that certificate

YOUR PERSONAL FILES ARE ENCRYPTED
Make payment or private key will be destroyed in
12 Hours 01:34
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was valid. Clever, huh? This means, as far as the system is concerned, the expired driver is valid and loaded, and you are screwed, my friend.

Or at least, you would be if you hadn't thought of such a scenario beforehand and mitigated against it. Back to Boris. "Organisations need a combination of best-in-class endpoint protection, strict policy enforcement, and proactive monitoring," Cipot said. "The detection of system configuration changes is also essential, as it's the system time changes that proved central to the failure of security protections in the case of the Medusa attacks."

I will just quickly add that you should ensure that Windows is configured so as to enforce the kind of strict revocation checks for signed drivers that would block such expired certificates before they could do any damage, whether they arrived in a Tardis or not.

FBI advisory

Talking of Medusa ransomware attack mitigations, back to the FBI and that cybersecurity advisory, reference AA25-071A (**tinyurl.com/370medusa**).

The mitigations are many and varied, but I'm going to cover them all here as they serve as a timely reminder of what's required to best defend against a multitude of cyber threats, not just Medusa or ransomware itself. Are you sitting down?

As I write this, it's actually World Backup Day (by the goddess, I hate these labels), so it seems fitting to start with implementing a recovery plan that maintains multiple copies of data and servers in physically separated, segmented and secure locations.

Next, passwords. Sigh. Get rid of them if possible; use passkeys. That aside, the FBI recommends not having a policy of regular password rotations, as this can weaken security instead of strengthening it. I offer password1, password2, password3, password4 as evidence, your honour. Oh, and require multi-factor authentication for everything, in particular webmail, virtual private networks and accounts that access critical systems.

Patch, patch, patch. In fact, patch everything: operating systems, software, firmware. Prioritise updating known exploited vulnerabilities in internet-facing systems.

Implement network segmentation to prevent any adversary lateral movement. Duh.

Talking of which, use endpoint detection and response tooling to get insight into the kind of network connections for every host that can help spot such lateral movement activity. Oh yes, and disable command-line and scripting activities and permissions. And unused ports. Did I say "duh" already?

Filter your network traffic to prevent unknown or untrusted origins from accessing remote services on internal systems. Audit user accounts with administrative privileges and apply the principle of least privilege to access controls.

If you don't trust Microsoft, don't use Windows

Trust is a funny old thing, especially when it is rooted primarily in privacy concerns. Take, for example, the use of Windows. Not wanting to use a Microsoft account to sign into your copy of Windows has been a thing since, well, Microsoft introduced the concept way back when. If I recall correctly, Windows 8.

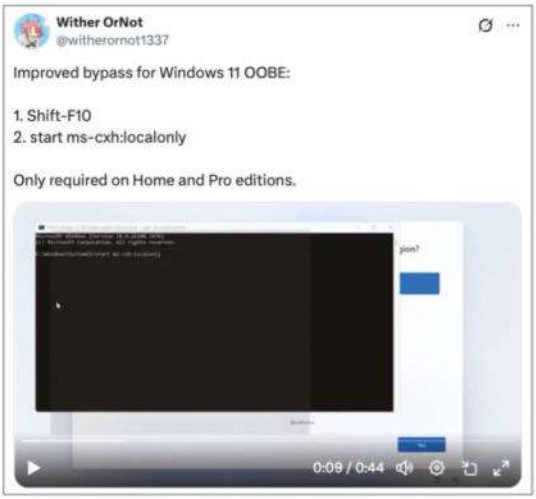
If my maths is right, that's some 13 years ago now. Unlucky for some, or so they thought, as not doing so quickly became a thing. Over the years, Microsoft has made it harder and harder for Windows users to take the local account option, mainly through the out-of-box-experience pushing cloud services and connectivity.

"When a user signs in with a Microsoft account, the device is connected to cloud services," Microsoft says. "The user can share many of their settings, preferences, and apps across devices." Which is, of course, true enough. A Microsoft account, which used to be called a Windows Live ID for my fellow old-timers out there, allows Microsoft sites, services, properties and computers to identify you.

ABOVE A report has revealed a 132% rise in ransomware attacks in quarter one of 2025

"Over the years Microsoft has made it harder and harder for Windows users to take the local account option"

BELOW There are ways around Microsoft's account login restrictions



No wonder, then, that privacy doubts have emerged that make a number of folks adamant they are simply not going to use it. Good luck with that if you use Windows 11. For hobbyist consumers, this has been a recurring theme, harking back to the good old days of system tweaking, with various hacks emerging to enable them to get around the Microsoft account OOBE sign-in. Perhaps the most popular, pretty much because it is by far the easiest, has been a command-line prompt of OOBEBYPASSNRO, but Microsoft is coming for that.

The latest Windows 11 Insider Program preview build, which is 26200.5516 as I write, has removed the bypassnro.cmd script to enhance the security and user experience of Windows 11, according to Windows Insider program managers.

Microsoft really, really wants you to have an internet-connected Microsoft account in this day and age when internet connectivity is ubiquitous. Who'da thunk it? "This change ensures that all users exit setup with internet connectivity and a Microsoft Account," those program managers said, stating the obvious.

And stating the obvious is what I'm going to do now. It's 2025, folks. If you really don't

Continued from previous page

trust Microsoft for privacy reasons as a consumer, then use a Mac or install Linux. It's not as if you're starved of choice.

Okay, with that mini-rant out of the way, what if you still want to stick it to Microsoft in a vain show of defiance? I've got some good news: even when bypassnro bites the virtual dust, there is another way, for now.

During the out-of-box-experience that is setting up a new Windows PC, and assuming you don't want to take your tweaking to the max with the use of unattend.xml via an ISO file installation image, a hacker on X found another simple bypass: hit Shift-F10 and type **start ms-cxh:localonly**. Yep, that's it. You're welcome.

And finally...

One of the most insidious uses of AI has been deepfakes in phishing attacks. Although this kind of deployment can be through audio or video, the intended outcome is the same: fooling the victim into doing something that someone they trust or is in a position of greater power asks them to do.

ABOVE Take the deepfake test at quiz.iproov.com: it's harder than you might think

Worryingly, a recent study by iProov found that only 0.1% of people could spot a deepfake image with any degree of accuracy. Of course, people being people, 60% were confident in their ability to spot them anyway. So, can you spot a deepfake? There's only one way to find out, and sorry, Harry Hill fans, it doesn't involve fighting.

Take the Deepfake Quiz at **quiz.iproov.com** that the bods at iProov have come up with. All you have to do is say whether an image is genuine or created by AI. Simple, huh?

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STEVE CASSIDY

"I got a long way into the project before it sank in that there were several new blind alleys"

As Steve prepares for the mother of all migrations, he explains the virtues of iSCSI and the sins of Apple's OS X

You may recall that, just before taking a break from normal subjects to address the likely technological impacts of a global war, I was idly announcing a future intention to upgrade my principal file store.

Let me run over the size and shape of this job. First of all, let's hear it for my principal Windows file server here, a little HP ML115 small business server, tweaked up just the way I like it. Lots of memory, an internal RAID made up of 750GB disks and a boot volume residing on an early SATA SSD.

There's also a four-port add-on gigabit Ethernet card, and this gives a clue to what this notionally humble and certainly old machine has going for it. This wasn't my main file store with just the disks mounted inside its cutesy casing: this was my iSCSI presentation layer.

I built it up with the help of a modern 10GbE-capable switch from Netgear and a grab-bag of diverse small business NAS devices – mostly the now extinct Lenovo four-drive ix200 series, but also a revolving set of Netgear and Synology two-drive devices. All they had to do was support operating as an iSCSI target, which in the obscure jargon of the storage world means that they can reserve a chunk of their disk array as a place for network-connected initiators to connect and lay out storage volumes in their own native partition and volume format.

Initially, I fought with this setup. From day one I was trying to start off with two of the ix200 devices and the basic, included motherboard Ethernet interfaces. It took far too much digging to realise that the onboard chipset in the ML115 was an Nvidia product and didn't support jumbo frames on its built-in network ports. If you've never researched this deep into network arcana, then I should point out that a jumbo frame can be *nine times* as large as a standard frame. A choice that is hardly visible at all in regular desktop use, but which makes the difference between a miserable 25MB/sec file access speed and 75MB/sec or more. So that was why I grabbed an Ethernet card off the junk pile, figured out its part number and, from there, its capabilities with better networking features.

Some people's reluctance with iSCSI comes from having poked about with the basic features of the Microsoft iSCSI initiator on an untweaked network, using a basic desktop PC as the initiator, and a bottom-end NAS as the target. The unwary experimenter will find that the volumes of traffic trying to share the tiddly PC's network interface – both normal file-sharing packets and the extra iSCSI traffic – will rapidly overwhelm the capabilities of the network. Packets are dropped: normal, right enough, for a standard Ethernet, but somewhat

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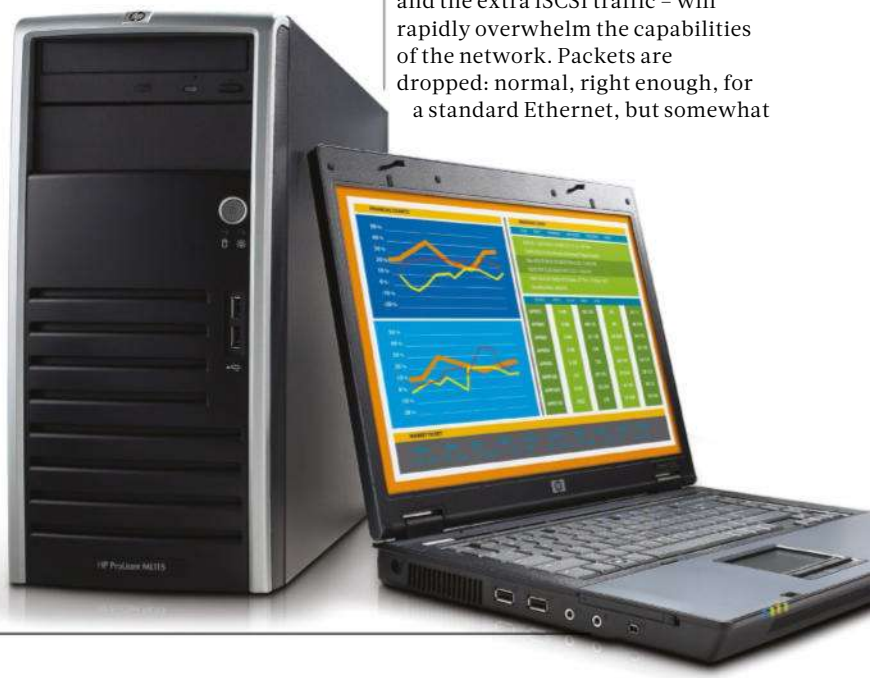
"I should point out that a jumbo frame can be nine times as large as a standard frame"

BELOW The HP ML115 small business server has been tweaked to exactly how I like



messy when it throws away about 10KB of iSCSI information.

Many conclude that this is a problem with the gaps in infrastructure claimed to be needed by a full-sized, high-performance, iSCSI-attached storage system. They will cite things such as a lack of iSNS services in a typical old-school Windows network. Some small NAS devices don't use iSNS to advertise themselves as targets; others have their own, hidden, always-on iSNS server, which works so invisibly that a lot of the more naive IT specialists don't believe it's actually there, or needed. It is.

By a process of experimentation, I settled on an implementation of iSCSI in my dingy basement, allowing up to four separate NAS boxes to each have their individual target and initiator addresses.

Some of this point-to-point traffic hopped between the ports of the Netgear 10GbE switch, though I failed miserably to control that by the end of the lifecycle of this setup. In the end, I had just as many NAS boxes connecting through some of the other switches in the server room, simply because I couldn't clear enough ports on the fast switch to keep the storage traffic local to that device.

However, digging into my server's iSCSI control panel, for a little while it was possible to relate the Post-it notes quivering on top of each NAS server to the entries in the Initiator panel on the presenting server. That was a sort of divine state in networking, and didn't last much more than seven years before my partner discovered a deep interest in digital photography, causing me to add NAS storage in a severely unplanned, purely responsive fashion.

At one point I had three NAS boxes talking to one of the pool of four available "storage" IP addresses – and I didn't even notice this happening, because I seldom put multi-machine loads to the server. In the end I established that some of the patches that update the iSCSI portion of the Windows network stack will reset the various preferences back to their installed defaults, no matter how good your reason might be to set them to something different.

ABOVE **One of my Mac Pro machines was adapted as a file server for my network**

Apple twist

Then I did something both foolish and unexpected. I had a client with a Mac Pro as their main file server.

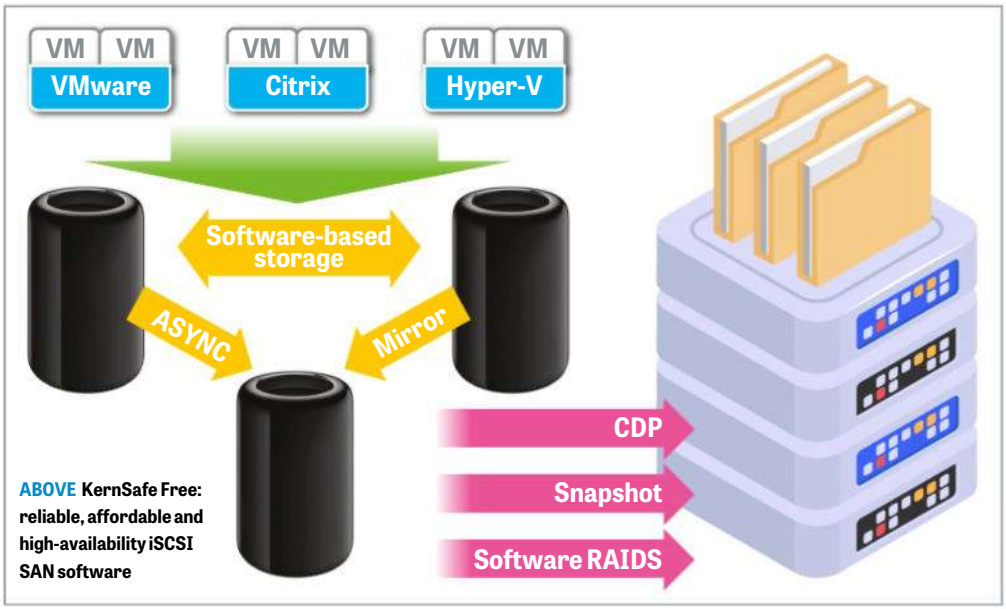
"Then I did something both foolish and unexpected"

I've used Macs for longer than I have PCs, but most of those weren't in a file-serving role, and the range of strange behaviours on their LAN had stymied two or three other tech and infrastructure companies before they asked if I wanted a go.

Not having seen a good, well-configured Apple file server in commercial use, I decided to get myself into the regular habit of using Apple's graphic-heavy admin tools, and the best way to achieve that was to leave myself no choice. Time to adapt one of my Mac Pro machines as a file server for my own network. Jumping about the GUI on that server would be the fastest way to get some idea of what was breaking the client's server.

A server called Lucky13

I name my servers by relevance to the incident that put them into service, and the build year when I put them together. My deceptively small and humble Xeon machine first spun up its disks in 2013, at a time when I was in no position to follow my own advice and avoid rushing things to an uncomfortable level. I was very lucky, during this emergency, to stand up the small sever before its older, bigger and failing neighbour finally died a death. So Lucky13 it was, and yes, that means I am now discussing replacing this machine some 12 years after I commissioned it.



ABOVE **KernSafe Free: reliable, affordable and high-availability iSCSI SAN software**

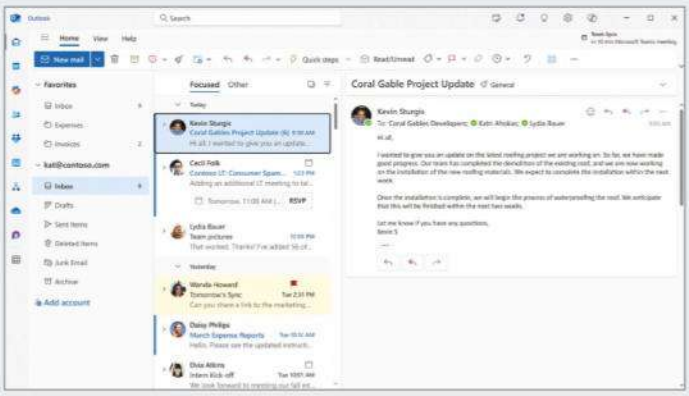
The Outlook thing, and virtualisation

When a stream release of a trusted utility goes so badly wrong that it directly affects your workflow, then you know it's bad.

I had to write an email about the row of houses I live in, specifically a structural issue at number 26. New Outlook decided I really meant to type 16, not 26, and I didn't notice before I pressed Send. Oh, how we laughed. Several members of our residents' group gave the full "back in my day" routine, remembering earlier versions that were neither as intrusive, nor so pigheadedly stupid. I stopped myself from pointing out how easy it is to go back to those older versions. Even on a laptop, all they need is the right desktop virtualisation suite, an appropriate volume format converter and a decent sized external storage device.

The last time I did a protective virtualisation to keep an outmoded email client functional and available, it took me about two hours of actual attended work and then a good night's sleep to let the conversion utility do its thing. At the end of that I had a bad email app in the main operating system of my laptop, and a good email app inside a virtual machine version of the preceding laptop used by the staff member who had bewailed his predicament.

Come on, guys – even those of you who were scarred and sceptical after tangling with version 1 of all the necessary virtualisation products – come back to the table and refresh your opinion on how hard the conversion process is, and how reliable the resulting pile of ghosts in the machine can be. Right now, I'd say an older copy of Outlook from, say, Office 2016 is far less likely to screw up or get in your way than the hot 2025 release of today's Outlook.



ABOVE An old virtualised copy of Outlook is less likely to go wrong than the 2025 version

I got a long way into that project before it sank in that there were several new blind alleys I'd introduced myself to. For one thing, despite having four "storage sleds" positively begging to be filled with drives, the Mac Pro doesn't come with a hardware RAID controller card as standard. This is a serious limitation, especially when you consider that there are suitable cards, but the way the drives are wired up to the storage controller area of the motherboard means there's no way to plumb in such a card – unless you want to completely decommission the onboard storage controller.

Can you see where this is going? Surely, all I had to do was hook up my impressive, ancient collection of NAS devices via the handy iSCSI protocol I bang on about so much... but then there's Apple's deep contempt for iSCSI. No free initiator applet for them! Some 20 revisions of OS X have come and gone, with perhaps half of those coinciding with the availability of OS X Server through the product lifecycles of the Mac mini server and the alloy-case, pre-trashcan Mac Pro.

I found my way to the KernSafe iSCSI initiator for OS X (see **tinyurl.com/370kernsafe**) and sat down with a coffee, confident that moving my varied file stores across to the new server would be easy enough the coffee wouldn't have time to go cold.

I whipped around the room collecting the Post-its with the NAS IP addresses on them, sat down, typed the first address into the Preferences app for iSCSI... and got a completely inaccessible volume. I could see what it was called, I could even pull up the odd picture of my partner watching Piers Corbyn do his human flamethrower act in Hyde Park, but it was a read-only presentation.

If you're an Apple person then you might know the reason for this curious behaviour already. As USB storage has become bigger, it comes pre-formatted as NTFS. Apples don't like to write to an NTFS volume, and it doesn't matter how those volumes are delivered. Could be by the humble USB or via a traditional FireWire or Thunderbolt port; it could be over a network layer like iSCSI. It doesn't matter. The scheme of populating a presented partition with a file system has to be Apple's own or FAT32, and that's it.

Remember at this point that iSCSI is a storage-access protocol, not a file system. You can attach any target you want, formatted at any time by any OS, and all iSCSI will do is deliver the packets. There's no compatibility guarantee, no translation, no included sync utilities. All of those are for you to research and implement. And, as in this case, occasionally bang your head against a brick wall.

"Despite setbacks such as this I remain a staunch iSCSI fan"

RIGHT USB storage comes pre-formatted as NTFS, which Apple machines don't like

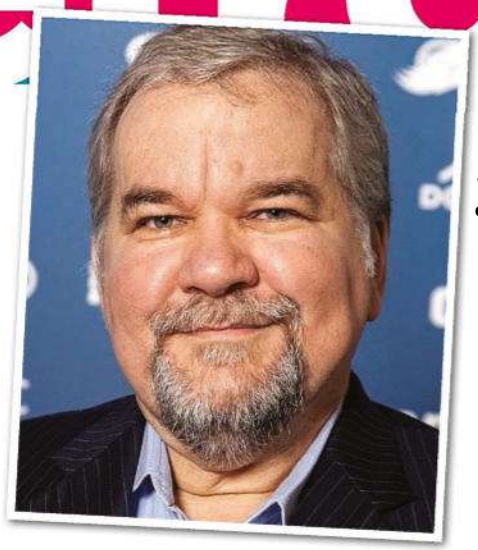
Despite setbacks such as this I remain a staunch iSCSI fan, because I've used it several times to prop up servers a lot worse off than mine. It's much safer to add or remove software-defined, network-attached storage than it is to whip the lid off and bombard the interior with SSDs.

Here's another reason I love iSCSI. IT suites working under stress have more than their fair share of physical mishaps. I can put my hand on my heart and say I've not seen a more resilient architecture against yanked out mains power, crushed patch leads and cavalier abuse of the Task Manager pop-up when all is not well. Even Exchange Server runs more reliably with the message bases out on external iSCSI target disk farms.

Going back to my project, I'm hoping that when I can actually download all the ISO images I need to stand up an Ubuntu 25 server, and then a NAS service on top of that infrastructure, I'll be reducing my core spindle count by about 22 drives in total. Formatting all the disks needed to hold what's on those smaller drives is another matter altogether.

I expect to have an update for you next month.

cassidy@well.com



LEFT Zimmermann gave PGP away for free, believing strong encryption was for all

One man's fight for digital privacy

When cryptographer Phil Zimmermann created the world's most widely used email encryption software, US prosecutors sought to lock him up. David Crookes acts for the defence

If you're writing someone a personal message, I'm guessing that you wouldn't be very happy if someone was taking a sneaky peek over your shoulder. It's the same online, which is why most people want to protect their privacy. It's also why many of us have come to love encryption software – tools that scramble readable data while it's being transmitted so that only the intended recipients are able to view it.

But if it wasn't for the efforts of activists and talented cryptographers such as Philip Zimmermann, there's no telling what systems we would have in place today. For his is a story of strong principles, political will, technical brilliance, determination and innovation. Not to mention great courage and perseverance.

Born in 1954, Philip Zimmermann was ten years old when he became interested in cryptology. "I'd read a children's book called *Codes & Secret Writing* and I learned about concepts such as substitution and transposition cipher while discovering how to make invisible ink out of lemon juice," he told *PC Pro*.

He later began writing his own encryption programs at college. "I wrote a program to add random numbers to each letter of a message, using a pseudo random number generator. After sending the message, the recipient subtracted those same random numbers. It was completely, absurdly naive."

As if to underline how much of a learning curve Zimmermann faced at the time, he came across one of the earliest textbooks about cryptography a few years later. The method of encryption he'd used in his college app was included as the focus for a homework assignment.

"I thought, 'ah, great minds think alike' and I felt so vindicated," he said. "But then I came to realise, with a great deal of embarrassment, that developing this algorithm was not the assignment – *breaking* this algorithm was.

"It was extremely humbling and I thought, 'okay, maybe I'm not so smart after all'. And you would have thought that I wouldn't make that mistake years later. But I did."

Bomb the bass

In June 1991, Zimmermann attended the International Association for Cryptologic Research (IACR) conference and he ran into one of the leading academic crypto analysts, Eli Biham. "I'd created my own block cipher, the BassOmatic, and I showed it to him," he said.

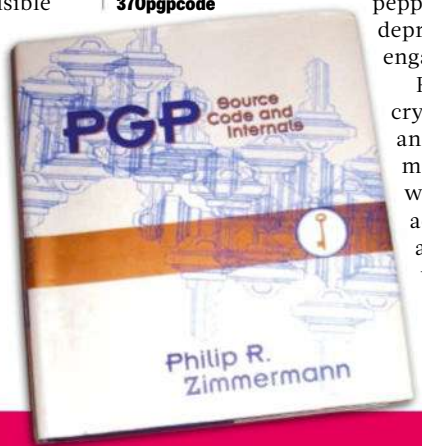
Zimmermann had been designing his symmetric-key cipher since 1988. "It was named after a *Saturday Night Live* skit in which [comedian] Dan Aykroyd was dropping whole fish into blenders to make a smoothie. I thought it was a funny name and used it because my software would scramble data just like the BassOmatic scrambled fish."

But when Biham sat down during the lunch break, Zimmermann was shocked. He'd spent ten minutes explaining how it worked. "Eli Biham then spent two minutes showing me how to break it and that was when I knew, okay, I'm stupid twice."

And yet Zimmermann is far from stupid. Quite the opposite, in fact, which makes his conversation – peppered with such self-deprecation – all the more engaging and approachable.

For while he was learning cryptology, finding his feet and inevitably making mistakes, Zimmermann was also willing to take advice on board, thereby avoiding falling prey to the Dunning-Kruger effect – "that's when somebody's stupid and they don't know they're stupid," he said.

BELOW You can see the *PGP Source Code and Internals* book at **tinyurl.com/370pgpcode**



Images: philzimmermann.com

It meant he could see the failings of BassOmatic, which formed part of his free mass-market encryption program for securing emails, and use that knowledge to create a rock-solid version. In doing so, this man of great intelligence and motivation was able to help shape the technological landscape forever more.

No puppet

To explain, BassOmatic formed part of what Zimmermann, in his typically modest way, named Pretty Good Privacy (PGP), and it was born out of his desire to ensure electronic communication was as safe and secure as possible.

He'd read the original Rivest-Shamir-Adleman (RSA) cryptosystem paper when it came out in the late 1970s while he was studying for a degree in computer science at Florida Atlantic University. "I wanted to implement RSA but I couldn't because all I had was an Apple II," he said.

In the mid-1980s, however, when he was working as an IT consultant in Boulder, Colorado, he began implementing RSA using the programming language C on the PC. There, he produced "standalone, little petri dish implementations" before deciding to bring it all together, motivated by the political landscape at the time.

"I was quite active in the 1980s," he said, referring to his past as an anti-nuclear demonstrator which saw him working as a military policy analyst on the Nuclear Weapons Freeze Campaign. This mass movement wanted the US and Soviet governments to halt the nuclear arms race, and Zimmermann's involvement saw him arrested twice (he was once in the same police jail as actor Martin Sheen and astronomer Carl Sagan).

"Ronald Reagan was president," Zimmermann said. "And he thought we were Soviet puppets. But I knew for sure that I wasn't a Soviet puppet and I knew a lot of people in the peace movement and I couldn't think of a single one of them who was a Soviet puppet.

"So what you have there is, if you want to try to be politically active on something that you know your government doesn't like, then maybe you need to protect yourself from your government. And if you live in a foreign country where human rights abuses are common, you certainly need protection from a government in those places.

"So my motivation for developing PGP was to protect Americans from their own government. If people were active on something the White House didn't like, they could be politically active and organised with some privacy."

SCO EXAMINER ★★★ Tuesday, September 21, 1993 D-3

Grand jury is investigating encryption software exports

ASSOCIATED PRESS

SAN JOSE — A federal grand jury is investigating exports of a controversial computer program in a case that could affect how software is distributed worldwide.

U.S. Customs officials asked for an investigation into ViaCrypt of Phoenix and Austin Code Works of Austin, Texas, and the companies' plans for foreign distribution of software, including PGP, a program that turns data into an indecipherable code using encryption technology.

William Keane, an assistant U.S. attorney, confirmed that an investigation is continuing, but declined to comment on the case.

The PGP program has been distributed worldwide over computer networks by some computer enthusiasts who oppose the U.S. government's trade regulations on encryption.

The National Security Agency, which monitors international communications, has supported strict encryption technology export regulations, arguing that it would be difficult to keep tabs on hostile governments and foreign terrorists.

But opponents say the restrictions hurt sales and violate the First Amendment that protects the right to publish information about encryption.

"I wrote PGP to make democracy healthier. I didn't do it to make money," said Philip Zimmermann, a computer consultant who developed PGP.

The crypto race

At the time, Zimmermann was earmarking communication via Bulletin Board Systems (BBS) – servers that allowed users to connect via a terminal program. "BBSes were all the rage," he said.

He was also in something of a race against time. "I ran into this rather disturbing thing, Senate Bill 266, which was a non-binding Sense of Congress resolution," he said. "It wasn't going to become law but it said communication technology companies should build backdoors to allow law enforcement to get to everything. Specifically, it wanted backdoors in encryption.

"That increased pressure on me to put pedal to the metal because I figured, well, right now it's a non-binding Sense of Congress resolution, but what about later? This could be an indication that it's going to become law, so I decided I had better release PGP while it was still legal to do so and change the facts on the ground.

"If I made it so that everybody had it, it would become far more difficult for the government to make a requirement to have backdoors."

TOP Zimmermann implemented RSA in the C programming language

MIDDLE PGP was embroiled in a legal dispute on its release

ABOVE Zimmermann worked on the Nuclear Weapons Freeze Campaign in the 1980s

My motivation was to protect Americans from their own government

As such, he worked on and incorporated that homegrown encryption algorithm, BassOmatic, which operated on blocks of 256 bytes and used a key to shuffle and transform data in complex ways such as by blending it based on control bits.

"It was not very good, cryptographically," said Zimmermann. But while the development nearly sent him under financially – "I'd missed five mortgage payments," he explained, "and I couldn't miss any more otherwise I'd lose the house" – it set the ball rolling.

PGP was then handed to a friend called Allan Hoeltje, who posted it to an ISP called Peacenet, which activists used across the world. Zimmermann also gave a copy to Kelly Goen, who uploaded it to a Usenet newsgroup specialising in distributing source code, marking it as US-only. Zimmermann thought this meant the program could only be downloaded in the US, but it spread globally; everyone was allowed to use it non-commercially without needing a licence.

Work also got under way on version two of PGP. Zimmermann decided to ditch BassOmatic in favour of code based on the International Data Encryption Algorithm (IDEA) – a symmetric-key block cipher designed by James Massey and Xuejia Lai.

"It was presented at the IACR conference and it was getting a lot of peer reviews, so I just decided to use that and it worked so much better," Zimmermann said.

The big difference between version one of PGP (based on BassOmatic) and version two (based on IDEA) was that the latter combined symmetric and asymmetric key cryptography.

Users would have a public encryption key and a private key known only to themselves. Messages sent would be encrypted using the receiver's public key and then unscrambled using the receiver's

private key. There was no central bank of private keys, making it very secure.

"Version two was released about 15 months after version one and it implemented the trust model which made PGP famous," he said. Development of the latter component was aided by Hal Finney, a strong advocate for individual privacy. "I knew what the trust model had to do and how it should do it, but he wrote all the code," Zimmermann said.

Trust in me

The "web of trust", as it's known, is a decentralised system that verifies identities. It establishes the authenticity of the binding between a public key and its owner and it was thus explained in the manual for PGP version 2.0:

"As time goes on, you will accumulate keys from other people that you may want to designate as trusted introducers," it states. "Everyone else will each choose their own trusted introducers. And everyone will gradually accumulate and distribute with their key a collection of certifying signatures from other people, with the expectation that anyone receiving it will trust at least one or two of the signatures. That will cause the emergence of a decentralized fault-tolerant web of confidence for all public keys."

Trust was key to Zimmermann, and it's also why he decided to write his manual using the first-person singular. "You don't need trust for word processors or computer games, but encryption software depends on it," he said.

"The idea of writing the manual in first-person singular was to allow people to read it and to hear it in my voice. It was me talking directly to the reader, which I felt would build more trust." Perhaps as a result of all of this, PGP became very popular.

It wasn't long, however, before US government officials got in touch with Zimmermann. "I was contacted by US customs in around February 1993," he recalled. "The customs agent said she wanted to ask me a few questions about PGP so I said, 'sure'.

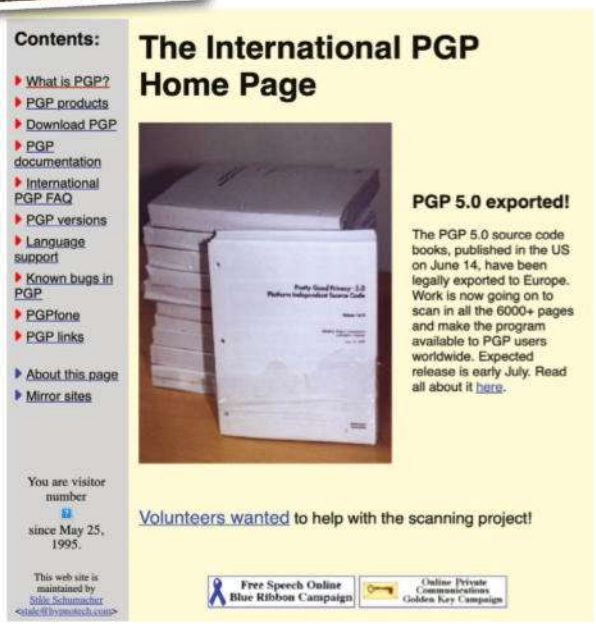
"I figured they needed some advice on how to deal with it and I was happy to talk but she said, 'well, we'd like to come and meet you in Boulder'. She was calling from San Jose, California,

I was worried. I had a family. I had two small children who would be homeless

and I suddenly understood that, no, you don't get two US customs agents getting on an airplane, flying from San Jose to Boulder, unless there's something important. This is not to get a tutorial. There must be some other motivation.

"So, because I couldn't just refuse, I contacted a criminal defence lawyer and he negotiated with them and we agreed to meet in my lawyer's office. I thought maybe I could defuse this if I talked to them. And so we did."

He was told that PGP looked to be in violation of the Arms Export Control Act. "It prohibited the export of munitions and there was a list of things that required a special licence from the State Department. If I wanted to export a helicopter gunship, I would need a licence. If I wanted to send stinger missiles to Libya, I would have to get a licence. One of the many, many things on the munitions list was encryption software."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PGP 5.0 exported!
The PGP 5.0 source code books, published in the US on June 14, have been legally exported to Europe. Work is now going on to scan in all the 6000+ pages and make the program available to PGP users worldwide. Expected release is early July. Read all about it here.
Volunteers wanted to help with the scanning project!
Free Speech Online Blue Ribbon Campaign
Online Private Communications Golden Key Campaign

BELOW PGP was acquired by Network Associates (now McAfee) in 1997

LEFT PGP was put under the same export restrictions as munitions

BOTTOM PGP was available for Unix, VMS, MS-DOS, Windows, OS/2, Mac, Amiga, Atari and Archimedes

Since PGP was being used outside the US, it was seen to have been exported. And because the encryption was so strong, the government wouldn't be able to easily break it. As such, it wasn't going to grant a licence. A criminal investigation ensued.

Although Zimmermann wasn't making any money from the project, the Department of Justice claimed PGP would allow terrorists and criminals to hide their activities, and he was looking at up to 52 months in prison if found guilty.

"I was worried. I had a family. I had two small children who would be homeless. I didn't think I would do very well in prison either," he said. "I got a legal defence team and I also decided I needed to talk to the press. I did one interview each day, five times a week, and 100% of the articles were in my favour, not 99%, not 99.9%, but 100%. They were critical of the government's position."

Devil in the detail

Having spent $100,000 in legal fees – the tab for which was mostly paid for by privacy rights activists – the charges in connection to the posting to Usenet in June 1991 were finally dropped in January 1996.

Zimmermann could rest easy and, eventually, strong cryptology was removed from US export restrictions. All western democracies also dropped their restrictions, meaning Zimmermann had truly triumphed.

Would he have written the program had he known the personal problems it would cause? "I did consider the possibility that something like this might happen but I didn't think they would go through with it because it's kind of absurd," he said.

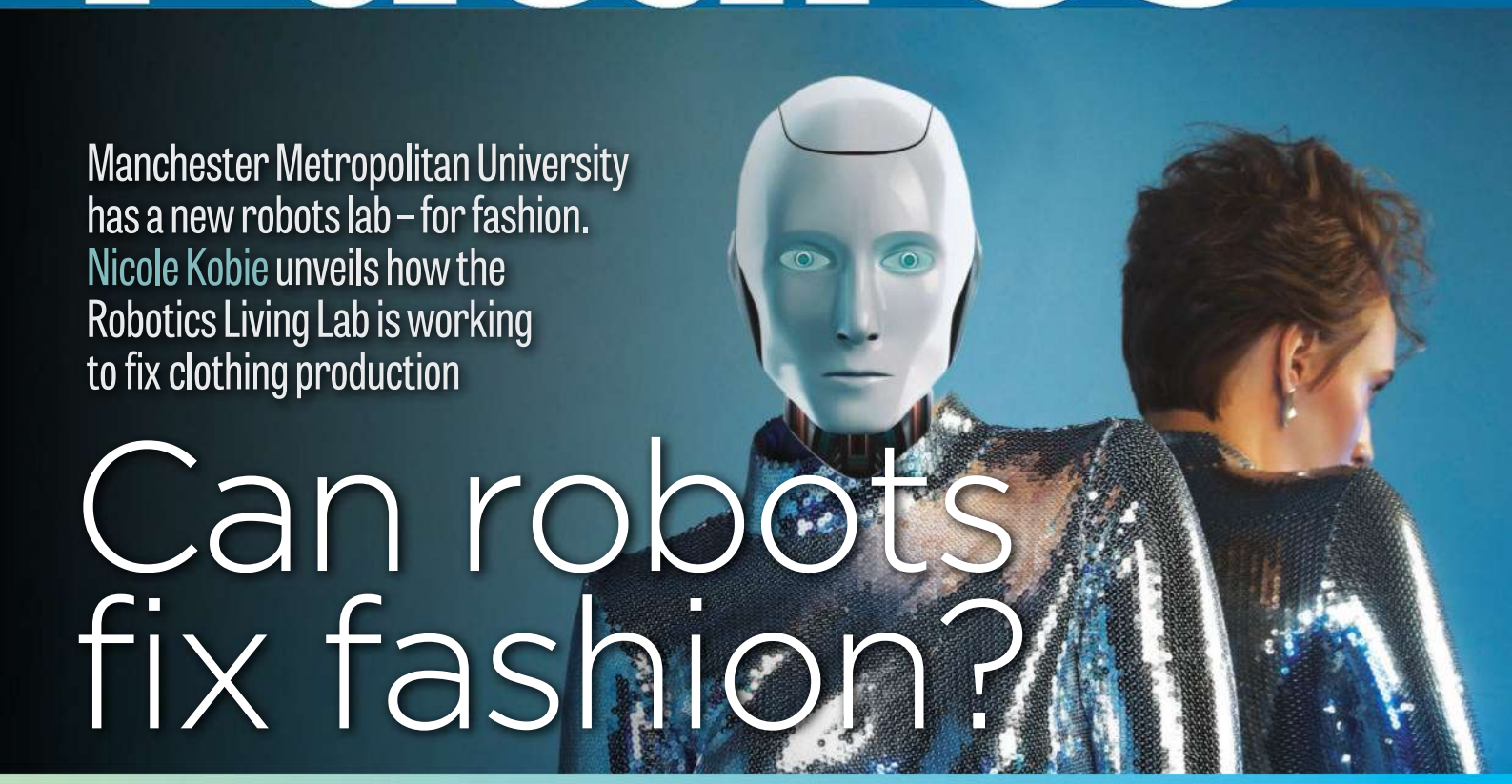
Ingeniously, this possibility had influenced the name of the product to some extent – a name that bore all the hallmarks of Zimmermann's tendency to play down his ability. "People would say, 'oh, shucks, what's all the fuss about – why are you getting so upset about something called Pretty Good Privacy?'"

"It was modest. It wasn't claiming to be the strongest thing ever – it just happened to *be* the strongest thing ever, at least with version two. I could have named it the encryption software from hell. You know, Satan's Diabolical Software. But no, no, no.

"And anyway, if I didn't work on this encryption software, someone else would have later. Maybe it would have just taken a little more time." ●

Images: Cornell University Library, US Marine Corps photo by Cpl Joseph Scanlan

Futures



Manchester Metropolitan University has a new robots lab – for fashion. Nicole Kobie unveils how the Robotics Living Lab is working to fix clothing production

Can robots fix fashion?

The Robotics Living Lab at Manchester Metropolitan University is trying to solve long-running robotics challenges. Nothing too special in that statement, but rather than sit in the computing or engineering department, this robot factory is part of the Manchester Fashion Institute.

Why? Robotics are central to manufacturing in most industries, but clothing production has challenges not seen in car factories or chip fabs – after all, fabric is soft, making it difficult to manipulate by machine hands. If there was some way to solve this then we could reduce the fashion industry's reliance on so-called sweat shops and allow it to finally catch up with the rest of the world.

As it stands, fashion has a monstrous impact on people and the environment. Offshoring to regions where people are paid less for their work raises ethical quandaries, exacerbated by poor treatment of workers, exemplified by the worst but by no means only example of the fire at Rana Plaza garment factory in Bangladesh that killed 1,134 people.

There's also the environmental impact of fashion, with the rise of plastic-filled fabrics that are difficult, if not impossible, to recycle. This leads to clothing being dumped in developing countries.

Can robots help solve such challenges? Could our metallic friends help to fix fashion?

What's here, and what we're waiting on

Some technology is on the horizon or here already. CNC-style laser cutting machines have been slicing patterns out of fabric for decades, and have recently added robotic assistance; existing machines knit at a pace unachievable by even the best wool warrior, for instance. Robots also help with tasks such as packaging, testing fabrics and manipulating even the most delicate materials.

For example, Robotextile created a system using Kuka industrial robots with custom grippers to carefully pick up thin layers of material and place it carefully to be sewn. Levi's used a robot-driven laser to "distress" jeans, slashing the time required from half an hour manually to 90 seconds. Let's hope someone alerts Nick Kamen.

BELOW Robotextile uses robots to pick up layers of material ready to be sewn

But sewing can be a tougher challenge. Startup company Sewbo attempted to address the problem by temporarily stiffening fabrics using water-soluble plastics for easier manipulation, but the system remains in development. SoftWear Automation's Sewbots manage pliable fabrics using AI-guided robots; while trials have been run, the system remains in development. Vienna's Silana makes the SiBot, to automate the entire sewing process, but the website still promises that a demo is coming soon.

In short, more work is needed. So the opening earlier this year of the Robotics Living Lab (RoLL) at the Manchester Fashion Institute is helping bring high tech to high fashion at just the right moment.

Building robots for fashion

Susan Postlethwaite had robotics in mind when she applied to work at Manchester Metropolitan University's Fashion Institute more than three years ago.

"I can remember describing a lab space in my interview," she told

PC Pro. "One of the visual triggers was an image that I had seen in a student's work at the RCA [Royal College of Arts] that involved a person sitting in an exoskeleton working on a car dashboard. All their tools were next to them suspended from the ceiling. This image really encouraged me to start considering why tools for the fashion industry hadn't really changed in 150 years."

A year into her work at the institute, Postlethwaite was awarded £3.8 million in funding from the Arts and Humanities Research Council to create the Robotics Living Lab.

"We were able to commission bespoke robot cells, buy collaborative small-scale robots, lots of gripper tool end effectors, and fit out the lab space with high-specification fashion-related technologies including a state-of-the-art sewing machine, knit and embroidery machines and 3D printers," she said. "We were set up to work with micro and SME businesses to collaborate on the kinds of tooling they could envisage for their workspaces, studios and micro factories."

Such equipment has a purpose: to improve the manufacturing of clothing with sustainability in mind. The best way to achieve that, RoLL research suggests, is reshoring or near-shoring, ending the practice of making clothing using "cheap labour" overseas before shipping finished garments across the world. (That said, it's worth noting that machine labour hasn't exactly ended offshoring in other industries, so there's more to solving these challenges than robots.)

Local production also enables circular economies. For example, clothing maker Rapanui uses robotics to take apart old clothing for recycling into new items, rewarding customers with discounts for returning worn out T-shirts.

That makes less economic sense if old shirts have to be shipped half-way around the world to be recycled and remade. Postlethwaite says: "If we can reshore then circular economic models become much more feasible."

Beyond labour ethics and sustainability, there are other reasons this could benefit the British fashion industry. "The new geopolitical landscape suggests very strongly that we need to produce more in the UK, and there is a new focus on robotics and manufacturing," she added.

How robots make clothes now

Cars, chips, mobile phones and many of the other goods we make using robotics are helpfully solid objects. As anyone who has tried sewing can attest, fabric is irritatingly flexible, with stretch and give that makes for a difficult task.

Teaching that to a robot is hard enough, but even more so given every fabric is different. "The deformable materials problem is very complex in terms of robotics, especially in a fashion context where you are dealing with floppy textiles," said Postlethwaite. "Currently robots are very good at pick and place tasks but not textile handling."

That's why startups such as Sewbo attempted to dodge the challenge by turning fabric stiff, making it easier to manage. "At RoLL we aim to develop a stitch tool but know that this will be a big challenge," she said.

TOP Huxxx xxx xx xx xds of Amstrad CPC users have connected their computers to Wi-ing the

ABOVE Huxxx xxx xx xx xds of Amstrad CPC users have connected their computers to Wi-ing the

The new geopolitical landscape suggests very strongly that we need to produce more in the UK

For help, RoLL is turning to external industry partners in Germany to develop what's known as a stitch end effector tool, which is a gadget that attaches to a robot's wrist for specific tasks – essentially, it's a robotic sewing hand for, as Postlethwaite calls it, "the business end of a collaborative robot arm".

Lots of tasks adjacent to sewing have already been automated, even if sewing itself is proving a challenge. For example, pressing and 3D knit and weave are both highly automated, but Postlethwaite notes that the latter requires a lot of skill to set up.

"We know there are volume manufacturers internationally who have largely deskilled the workforce by automating so many tasks," said Postlethwaite. "This is the reason at RoLL we think collaborative robotics are the way forward."

And for all we know, exciting things may be happening behind closed doors. There's a limit to how much is shared about the state of robotics innovation in the industry because of non-disclosure agreements and other IP protection. "I think we can speculate that there is a lot of development currently happening behind the scenes," she said.

RoLL robots

RoLL has already produced plenty of its own tools to help the clothing production industry.

"We have developed several bespoke collaborative robot cells at the lab that include a vacuum table, magnetic tabletop and the ability to suspend collaborative robots from multiple angles – horizontal, top to bottom and side mounted – to deliver different capabilities," Postlethwaite said.

To develop such technologies, RoLL worked with small-scale UK companies. With POMO Robotics, the lab spent 18 months developing a rotary cutting tool end effector for collaborative robots. It's been through three design stages with tweaks made for operability, ease of use, and health and safety, with the lab saying it's at a technology readiness level of six or seven out of nine.

Not all down to robots

While this article focuses on the role robots will hopefully play when it comes to fixing fashion, it's not the only role tech is playing. For example, there's research into new materials that will biodegrade more quickly, while a handful of companies are using blockchain to add transparency to supply chains. These are all reasons to be optimistic in the future.

But for now, there are things we can do. If your favourite online retailer offers AR or VR options for trying on clothes, give it a try. Use apps such as Depop and Vinted to buy and sell "preloved" clothing. Digitising your existing wardrobe (try apps such as Whering) may also make you realise you already own clothing similar to what you were considering buying.

Fundamentally, we can't ignore the fact that our consumption habits are part of the problem. Cheap fast fashion shouldn't be the norm. Well-made pieces with high-quality materials are now more accessible and affordable thanks to technology, and changing how we buy clothing today will still have a big impact while we await robots that can cut and sew.

The lab also worked with Innovo Robotics. "Innovo produced for RoLL a fully enclosed demonstrator cell so that we can showcase to visitors what we are doing without the need for health and safety training," she said. "Innovo cobots are reconfigurable, which makes them very versatile in terms of reach and we are using these a lot currently."

But the longer-term aim is to create end effectors for robots that can be used in fashion production. One is already built, but still undergoing fine-tuning. RoLL started with a cutting tool to help small businesses. "We know from our research that cutting out manually created a serious bottleneck in the production process, so this is the first tool we have developed," Postlethwaite said.

"We would like to make this tool open source with a Creative Commons licence so that we can share with other labs, enabling them to develop on from where we are, with attribution as to the originators of course."

Next up is a stitching tool and a universal former, for making different sizes. "We have been influenced by the tooling development in the automotive and aerospace industries to think about smaller-scale tooling than the huge industrial robots employed there, but with similar capabilities," Postlethwaite explained. "The cobot technology will come into its own where a skilled human operator will be able to place textile to be stitched by a robot."

Indeed, in her view, robots will always remain just one part of clothing production, with human expertise remaining essential to keep in the loop. "Manual handling of textiles is an important aspect to making and a sensory experience so it's important to keep these skills," she said. "At RoLL we talk about taking the tool to the textile rather than the more conventional way of taking the textile to the machine."

ABOVE Susan Postlethwaite is pioneering the use of robots in fashion

What's holding it all back?

Robotics and fashion can feel worlds apart, and that's part of the problem – there aren't enough people with expertise in both clothing production and robotics. "The fashion industry in the UK is currently facing a severe skills shortage," said Postlethwaite.

And that means training is, as ever, crucial to these nascent technologies.

What's more, as we shift from existing practice to these new ideas, we need to be wary of energy use, the environmental impact of creating and decommissioning robotics, and much more besides. After all, if we trade landfills full of cheap T-shirts for those full of electronics, we haven't improved much.

"We will need to be aware of zero carbon legislation on the horizon and the development of robotics in the build, in use and the decommissioning phase," Postlethwaite said. "We will also need to do further research around the rare minerals and metals used in the construction of robotics and consider the ethics of where they are found, what alternatives are currently being developed, where they are mined and by whom."

Otherwise, we're trading one problem for another when it comes to sustainability and ethics in fashion.

Beyond that, Postlethwaite hopes to get the fashion industry recognised in the UK's new Industrial Strategy, which includes creative industries but not fashion – despite the huge importance to the UK economy. "Fashion should be recognised as a cornerstone of creative industries straddling both design and manufacture as CreaTech," she argued, referencing the idea of creativity pairing with technology.

If we can get it right, robotics could help reshore textiles production to the UK, offering better-quality clothing at a lower cost that's made sustainably with ethics in mind, all while staying globally competitive. Robot-made clothing won't end fast fashion, but it could give us tools to address such challenges in the industry.

Manual handling of textiles is an important aspect to making so it's important to keep these skills

PC PRO Next month

ON SALE
Thursday 3 July

Features

You and AI are gonna live forever

With AI able to recreate your look, your voice and capture everything you've been thinking about, digital immortality is now a possibility.

Features

Displays: the expert guide

Confounded by contrast ratios? Doubtful about Delta E? Darien Graham-Smith takes a close look at the specs and capabilities that allow the best screens to, quite literally, shine.

Features

Auracast: Bluetooth's broadcasting future

Auracast is going to change the way we listen to audio in public spaces, and make life considerably easier for people with hearing difficulties. We explain how.

Labs

Affordable laptops

If you have no intention of spending over a grand on a laptop, next month's Labs is for you. We find out exactly what you can get for your money, including the best Chromebooks.

Retro

Dragon 32

Many people have fond memories of this Welsh-born computer, but what's the story behind its creation? We speak to one of the key people involved to find out.

The Network

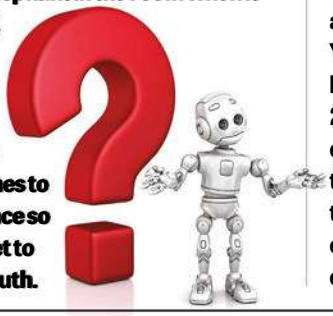
Cloud backup

Whether it's through attack or error, your business data is always at risk. Dave Mitchell explains how cloud services can add extra protection and puts four contenders to the test.

Futures

Idioms vs LLMs (or how to confuse an AI)

There's an elephant in the room when it comes to AI, and that's its utter confusion over idioms. We're not ones to sit on the fence so bite the bullet to reveal the truth.



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Don't read this column unless you want to waste at least an hour of your life, says Jon Honeyball

You know that sinking feeling you get when you land on a website and you're instantly sucked in? Down the rabbit hole you go, either in amazement at wonderful things or in mild horror at what's being presented. Sometimes it can be educational, sometimes fun. Sometimes it's deeply disturbing, and you back away from the keyboard, not quite knowing how to process what has just been experienced.

Today I had a mixture of all of that. Because I fell upon a website called National Day Calendar (**nationaldaycalendar.com**).

This site details all the "National Day of Something" that seems to be happening all the time. It's a very well presented website without a hint of parody. You can search by all sorts of useful parameters, but my own rabbit hole was its International Day page.

Did you know that 4 January is World Hypnotism Day? Click on the page and you're taken to a fact-filled page all about it. I had no idea a World Hypnotism Day Committee had been set up to bring this to life, and I now feel strangely compelled to tell you to visit **worldhypnotismday.com**.

World Braille Day takes place on 4 January, too, so best not to accept any laser-printed calendar invites for that day. Not that there's anything wrong with the day's aims: it's there to remind us all about Braille and the ways it's supported in various apps and platforms. Definitely a good thing. Accessibility Support is there for everyone to use, irrespective of our needs.

But it isn't just days; there are whole weeks, too. The last full week in January is Global Crayola Creativity Week. Who knew?

I must, however, call into question 8 January, which is Earth's Rotation Day. I hadn't appreciated that Mother Earth's ego was so fragile that she needed recognition to summon up the energy to keep rotating, but I confess I found this an educational rabbit hole.

To escape the clutches of January sadly we must pass over 21 January, which is International Sweatpants Day. Truly our cup runneth over.

But wait, there's more: 2 May is World Tuna Day. The first Saturday in May is World Naked Gardening Day, so it would be best to check the weather forecast. And who could miss 15 May's International Kangaroo Care Awareness Day? I'll make sure I warm my teapot specially for 21 May's International Tea Day, which is officially approved by the United Nations. It says: "Ever since 2005, tea-producing countries banded together to celebrate an International Tea Day. These countries included Sri Lanka, Nepal, Indonesia, Kenya, Malaysia and Uganda. In 2019, the Intergovernmental Group on Tea proposed to celebrate International Tea Day on 21 May."

Of course, it's easy to be flippant about these things, as you may have noticed, and to ponder whether International Nurses Day is only for those who travel abroad.

But the sobering reality is that, among the fun, there are innumerable serious issues that need to be discussed, and maybe having an International Day marking it is what's needed to get the mainstream media to discuss these things. I can't see my mates in the pub reminding me on 22 May: "Oi, Jon, it's World Goth Day today, and here's how we're celebrating it." But 30 May is World Multiple Sclerosis Day, and that is worth a few moments of thought. As is 21 September for World Alzheimer's Day, because my late Dad had that. And 18 August for World Never Give Up Day.

World Mosquito Day on 20 August might seem a little strange, to celebrate that insect. But we should remember the devastation that malaria, dengue fever, yellow fever and so forth brings upon vast numbers of people every year. Awareness can surely only be a good thing.

As all this illustrates, balancing the good from the trash is hard, and if anything the National Day Calendar is merely a microcosm of the world wide web, where it's becoming increasingly difficult to separate the useful from the noise. The background level of nonsense has now increased to the point where it's drowned social media in almost every form. My cynicism is such that I might not even believe that the third Saturday in August is World Honey Bee Day, although, with my surname, I guess I'm likely to celebrate that anyway.

> "There are serious issues that need to be discussed, and maybe an International Day is what's needed to get the mainstream media to discuss these things"

But here's the good news. It seems that some dates are less popular than others, with the only listing on 16 June being National Fudge Day. At the top of the site, we're invited to "Register a National Day". So how about International Politicians Telling the Truth Day? Actually, let's make that a week. Or even a month. I'd vote for International Fix Your Bugs Day, too.

Maybe there's even room for National Jon Day, celebrating all the fine work done by those with the less common spelling? If not, surely we can get a few thousand votes for an International Day of *PC Pro*?

Jon Honeyball is a founding editor of *PC Pro* and has, for the past 61 years, aimed to make every day special. Email jon@jonhoneyball.com

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